



Channabasaveshwara Institute of Technology

(Affiliated to VTU, Belgaum & Approved by AICTE, New Delhi)

(NAAC Accredited & ISO 9001:2015 Certified Institution)

NH 206 (B.H. Road), Gubbi, Tumkur – 572 216. Karnataka

QMP 7.1 D/F



Department of Mechanical Engineering

SPREAD SHEET FOR ENGINEERS

BME358C

B.E - III Semester

Lab Manual 2025-26

Name : _____

USN : _____

Batch : _____ Section : _____



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Department of Mechanical Engineering

Spread Sheets for Engineers- Manual

Academic Year 2025-26

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DEPARTMENT OF MECHANICAL ENGG.

Spread Sheet for Engineers Lab Syllabus

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIE	
Spread Sheet For Engineers	BME358C	02	0-0-2	50	50	3 Hrs

Course objectives:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis.
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

SI NO	Experiments
1	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units
3	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.
5	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.
6	Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.
7	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.
8	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.
	Demonstration Exercises
9	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.
10	Demonstration of reading, writing and organizing files.
11	Differential Equations: Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis.
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros

To carryout numerical integration and solving differential equations using different methods

Reading:

1. McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition



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Institutes' Vision

To create centres of excellence in education and to serve the society by enhancing the quality of life through value based professional leadership.

Institutes' Mission

- To provide high quality technical and professionally relevant education in a diverse learning environment.
- To provide the values that prepare students to lead their lives with personal integrity, professional ethics and civic responsibility in a global society.
- To prepare the next generation of skilled professionals to successfully compete in the diverse global market.
- To promote a campus environment that welcomes and honors women and men of all races, creeds and cultures, values and intellectual curiosity, pursuit of knowledge and academic integrity and freedom.
- To offer a wide variety of off-campus education and training programmes to individuals and groups.
- To stimulate collaborative efforts with industry, universities, government and professional societies.
- To facilitate public understanding of technical issues and achieve excellence in the operations of the institute.

Department Vision

- To create state of the art learning environment to nurture the learning.
- Blending human values, academic professionalism and research process in the field of mechanical engineering.
- Blending human values, academic professionalism and research process in the field of mechanical engineering for the betterment of society.

Department Mission

The mission of the department is to

- Provide requisite foundation to our students in Mechanical Engineering.
- Provide cutting edge laboratory resources to bridge the gap between theoretical and practical concepts.
- Provide exposure to various mechanical industries through periodic industrial visits.
- Enhance our students skill set and to make them industry ready by systematic skill development program.



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DEPARTMENT OF MECHANICAL ENGG. CAD LAB LAYOUT



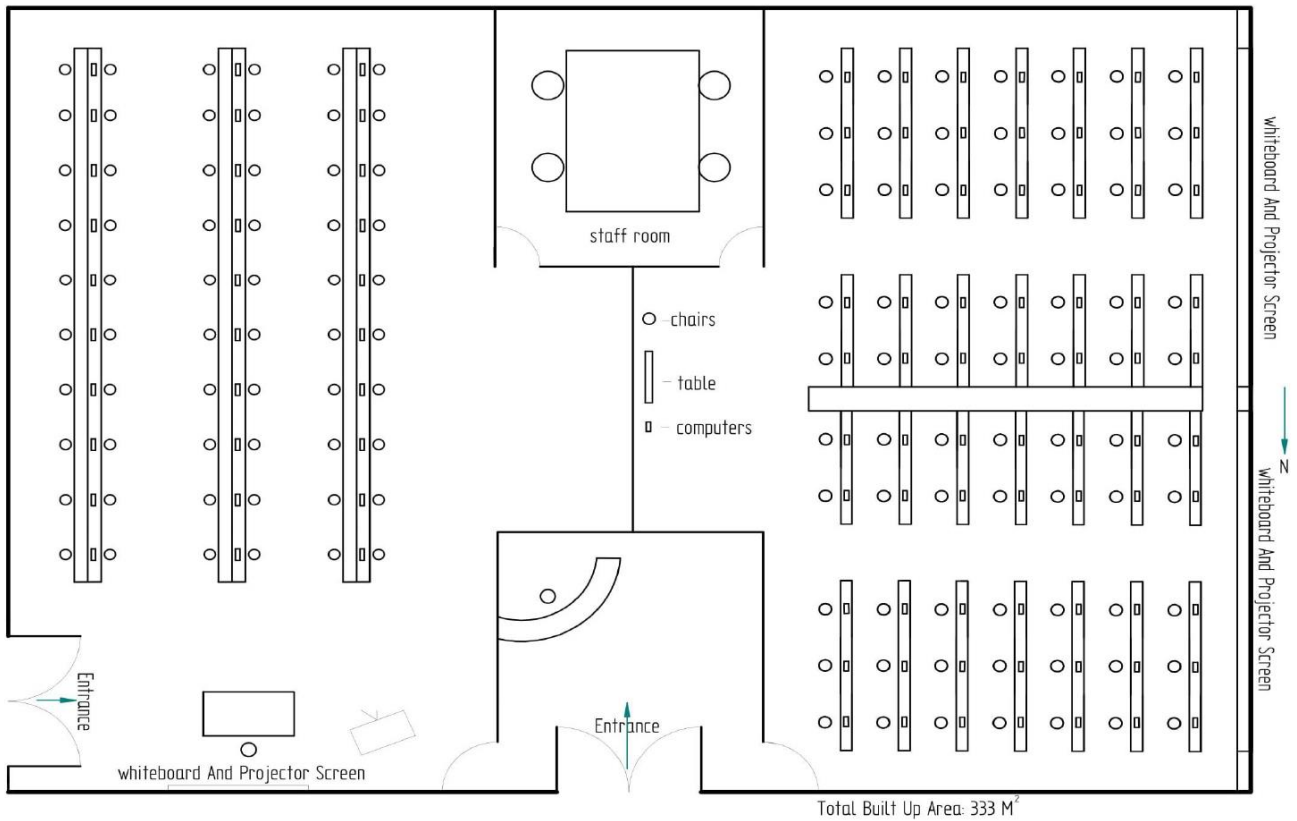
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DEPARTMENT OF MECHANICAL ENGINEERING

Layout Of CAD Lab





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List Of Experiments

Sl No	Experiment Name
1	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart
2	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using the CONVERT Function to Convert Units
3	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.
4	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis Tool Pack.
5	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using the Solver to Find Roots, Finding Multiple Roots, Optimization Using the Solver, Minimization Analysis, Nonlinear Regression Analysis.
6	Matrix Operations Using Excel: Adding Two Matrices, multiplying a Matrix by a Scalar, Multiplying Two Matrices, transposing a Matrix, inverting a Matrix and Solving System of Linear Equations.
7	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The for Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function the Excel Object Model, For Each Next Structure.
8	VBA Subroutines or Macros: Recording a Macro, coding a Macro Finding Roots by Bisection, Using Arrays, adding a Control and Creating User Forms.
Only for Demo	
9	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, creating a User-Defined Function Using the Simpson's Rule.
10	Differential Equations: Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation



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DEPARTMENT OF MECHANICAL ENGINEERING

LECTURE PLAN

Faculty Name: Dr. Sushma S

Sem. & Sec.: III 'A'

Sub: Spread sheet for engineers

Sub. Code: BME358C

Sl. No.	Date	Lesson Plan No.	Name of the Experiment	Remarks
Batch				
1		LP.1	Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot	
2		LP.2	create a combination chart	
3		LP.3	Computing Sum, Average, Count, Max and Min, Computing Weighted Average	
4		LP.4	Trigonometric Functions, Exponential Functions, Using the CONVERT Function to Convert Units	
5		LP.5	Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver	
6		LP.6	AND, OR and XOR functions	
7		LP.7	Trendline, Slope and Intercept, Interpolation and Forecast	
8		LP.8	Finding Multiple Roots, Nonlinear Regression Analysis.	

9.		LP.9	Adding Two Matrices, multiplying a Matrix by a Scalar, Multiplying Two Matrices	
10.		LP.10	Transposing a Matrix, inverting a Matrix and Solving System of Linear Equations.	
11.		LP.11	Revision	
12.		LP.12	Lab IA	

EXTRA LABS

Month	DATE

Signature of staff

HOD



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Safety Precautions to the Students.

1. Students are advised to come to the laboratory at least 5 minutes before (to the starting time), those who come after 5 minutes will not be allowed into the lab.
2. Plan your task properly much before to the commencement, come prepared to the lab with the synopsis / program / experiment details.
3. Student should enter the laboratory with:
 - a. Laboratory observation notes with all the details (Problem statement, Aim, Algorithm, Procedure, Program, Expected Output, etc.,) filled in for the lab session.
 - b. Laboratory Record updated up to the last session experiments and other utensils.
(If any) needed in the lab.
 - c. Proper Dress code and Identity card.
4. Sign in the laboratory login register, write the TIME-IN, and occupy the computer system allotted to you by the faculty.
5. Execute your task in the laboratory, and record the results / output in the lab observation notebook and get certified by the concerned faculty.
6. All the students should be polite and cooperative with the laboratory staff, must maintain discipline and decency in the laboratory.
7. Computer labs are established with sophisticated and high-end branded systems, which should be utilized properly.
8. Students should LOG OFF/ SHUT DOWN the computer system before he/she leaves the lab after completing the task (experiment) in all aspects. He/she must ensure the system / seat is kept properly.



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DEPARTMENT OF MECHANICAL ENGG.

Course Objectives & Outcomes.

Course objectives:

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- To carryout matrix operations
- To Understand VBA and UDF
- To understand VBA subroutines and Macros
- To carryout numerical integration and solving differential equations using different methods

Course Outcomes:

At the end of the course students are able to

- To create different plots and charts
- To compute different functions, conditional functions and make regression analysis.
- To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis
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6	Matrix Operations Using Excel	139
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8	VBA Subroutines or Macros	157

EXPERIMENT-1

Date:

Aim: Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart

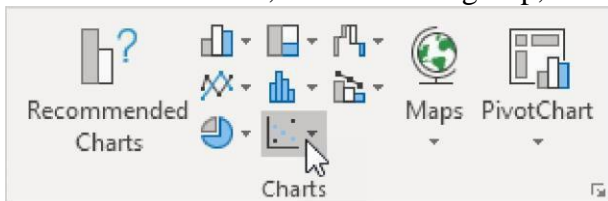
Use a scatter plot (XY chart) to show scientific XY data. Scatter plots are often used to find out if there's a relationship between variable X and Y.

To find out if there is a relationship between X (a person's salary) and Y (his/her car price), execute the following steps.

1 . Select the range A1 :B1 0 .

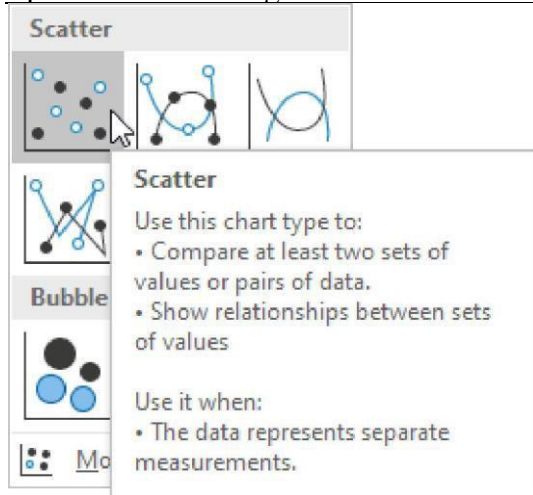
	A	B	C
1	X (Salary)	Y (Car Price)	
2	\$42,763	\$19,455	
3	\$195,387	\$93,965	
4	\$35,672	\$20,858	
5	\$217,637	\$107,164	
6	\$74,734	\$34,036	
7	\$130,550	\$87,806	
8	\$42,976	\$17,927	
9	\$151,132	\$91,518	
10	\$54,936	\$29,479	
11			

2 . On the Insert tab, in the Charts group, click the Scatter symbol.

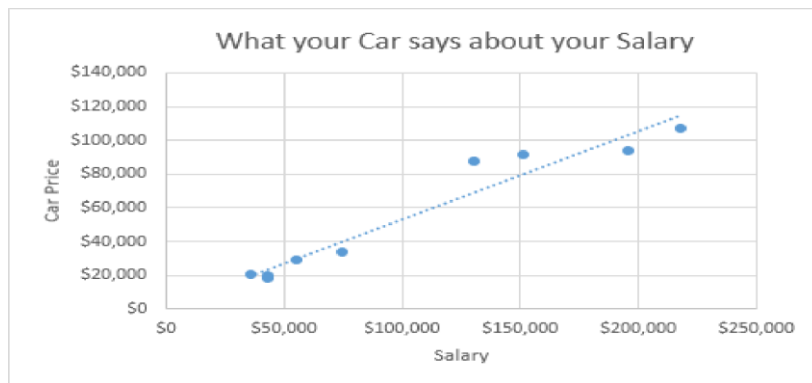


3 . Click Scatter.

Spread Sheet for Engineers



Result:

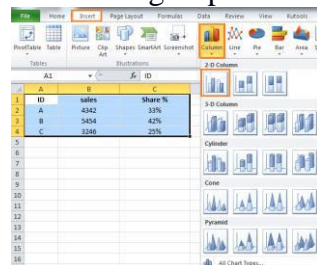


Note: we added a **trendline** to clearly see the relationship between these two variables.

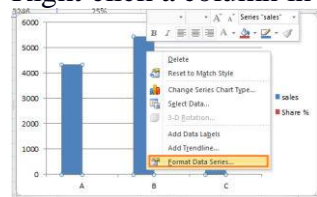
2. On the Insert tab, in the Charts group, click the Scatter symbol.

Two Y Axis and Combination Chart

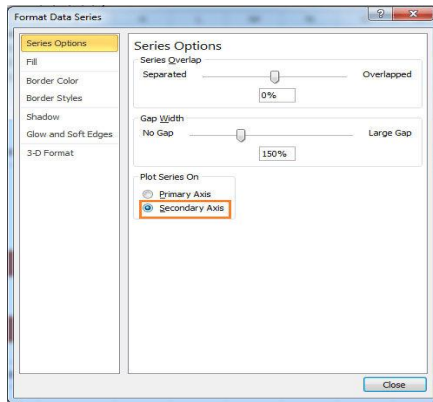
1. Select the data range and insert a chart first by clicking **Insert** and selecting a chart you need in the **Chart** group.



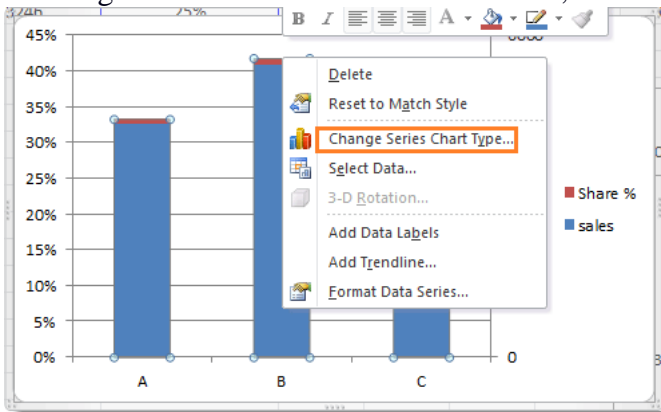
2. Right click a column in the chart and select **Format Data Series** in the context menu.



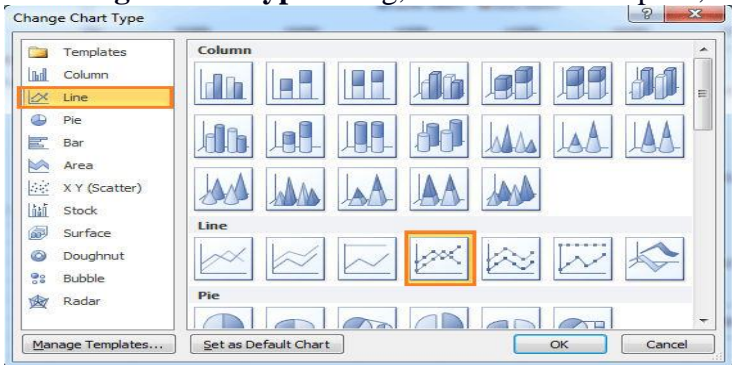
- Then in **Format Data Series** dialog, check **Secondary Axis** in the **Plot Series On** section, and click the **Close** button.



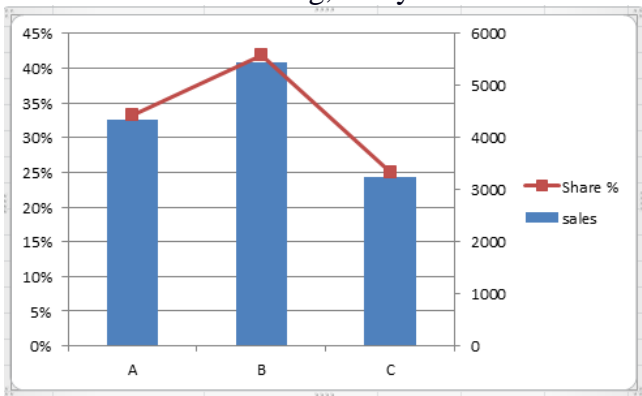
- Then right click the red column in the chart, select **Change Series Chart Type**.



- In **Change Chart Type** dialog, click **Line** in left pane, and select the line chart type you like.



- Click **OK** to close dialog, and you see the chart is inserted with two y axes.



Error Bars

1. On 2-D area, bar, column, line, xy (scatter), or bubble chart, do one of the following:
 - To add error bars to all data series in the chart, click the chart area.
 - To add error bars to a selected data point or data series, click the data point or data series that you want, or do the following to select it from a list of chart elements:

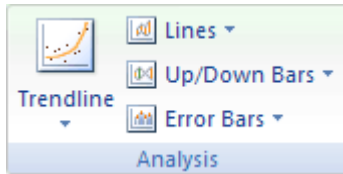
- i. Click anywhere in the chart.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

- ii. On the **Format** tab, in the **Current Selection** group, click the arrow next to the **Chart Elements** box, and then click the chart element that you want.



2. On the **Layout** tab, in the **Analysis** group, click **Error Bars**.



3. Do one of the following:
 - a. Click a predefined error bar option, such as **Error Bars with Standard Error**, **Error Bars with Percentage**, or **Error Bars with Standard Deviation**.
 - b. Click **More Error Bar Options**, and then under **Vertical Error Bars** or **Horizontal Error Bars**, click the display and error amount options that you want to use.

EXPERIMENT-2

Date:

Aim: Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using the CONVERT Function to Convert Units.

SUM function

The SUM function adds values. You can add individual values, cell references or ranges or a mix of all three. For example: =SUM (A2:A10) Adds the values in cells A2:10. =SUM (A2:A10, C2:C10) Adds the values in cells A2:10, as well as cells C2:C10

AVERAGE function in Microsoft Excel.

=AVERAGE (A1:A20)

COUNT function:

The COUNT function counts the number of cells that contain numbers and counts numbers within the list of arguments. Use the COUNT function to get the number of entries in a number field that is in a range or array of numbers. For example, you can enter the following formula to count the numbers in the range A1:A20: =COUNT (A1:A20). In this example, if five of the cells in the range contain numbers, the result is 5.

Min, Max Functions:

Min (expr)

Max (expr)

Find a Weighted Average:

Use the SUMPRODUCT and the SUM functions to find a Weighted Average, which depends on the weight applied to the values.

For example, a shipment of 10 cases of pencils is 20 cents per case. But a second shipment of 40 cases costs 30 cents per case, because pencils are in high demand. If you averaged the cost of each shipment this way $(0.20+0.30)/2 = 0.25$, the result isn't accurate.

The math doesn't take into account that there are more cases being sold at 30 cents than at 20 cents. To get the correct average, use this formula to get the result (28 cents per shipment):

=SUMPRODUCT(A2:A3,B2:B3)/SUM(B2:B3)

The formula works by dividing the total cost of the two orders by the total number of cases ordered.

Example: When the Weights Add Up to

100%

	A	B	C	D
1	<i>Exam</i>	<i>Marks</i>	<i>Weightage</i>	
2	Assignment 1	86	5%	
3	Assignment 2	66	5%	
4	Quiz 1	95	5%	
5	Quiz 2	84	10%	
6	Project	85	25%	
7	Viva	78	10%	
8	Exam	67	40%	
9	Weighted Average	76.6		

Formula bar: =SUMPRODUCT(B2:B8,C2:C8)

When Weights Don't Add Up to 100%

Wrong:

	A	B	C	D	E
1	<i>Exam</i>	<i>Marks</i>	<i>Weightage</i>		
2	Assignment 1	86	10%		
3	Assignment 2	66	10%		
4	Quiz 1	95	10%		
5	Quiz 2	84	20%		
6	Project	85	50%		
7	Viva	78	20%		
8	Exam	67	80%		
9	Weighted Average	153.2			

Formula bar: =SUMPRODUCT(B2:B8,C2:C8)

Correct:

	A	B	C	D	E	F	G	H
1	<i>Exam</i>	<i>Marks</i>	<i>Weightage</i>					
2	Assignment 1	86	5%					
3	Assignment 2	66	5%					
4	Quiz 1	95	5%					
5	Quiz 2	84	10%					
6	Project	85	25%					
7	Viva	78	10%					
8	Exam	67	40%					
9	Weighted Average	76.6						

SIN(number)

The SIN function syntax has the following arguments:

- **Number** Required. The angle in radians for which you want the sine.

Remark

If your argument is in degrees, multiply it by PI ()/180 or use the RADIANS function to convert it to radians.

Example

Copy the example data in the following table and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Formula	Description	Result
=SIN(PI())	Sine of pi radians (0, approximately).	0.0
=SIN(PI()/2)	Sine of pi/2 radians.	1.0
=SIN(30*PI()/180)	Sine of 30 degrees.	0.5
=SIN(RADIANS(30))	Sine of 30 degrees.	0.5

COS Function:

Description

Returns the cosine of the given angle.

Syntax

COS(number)

The COS function syntax has the following arguments:

- **Number** Required. The angle in radians for which you want the cosine.

Remark

If the angle is in degrees, either multiply the angle by $\text{PI}()/180$ or use the RADIANS function to convert the angle to radians.

Example

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Formula	Description	Result
=COS(1.047)	Cosine of 1.047 radians	0.5001711
=COS(60*PI()/180)	Cosine of 60 degrees	0.5
=COS(RADIANS(60))	Cosine of 60 degrees	0.5

TAN function

Excel for Microsoft 365 Excel for Microsoft 365 for Mac Excel for the web [More...](#)

This article describes the formula syntax and usage of the **TAN** function in Microsoft Excel.

Description

Returns the tangent of the given angle.

Syntax

TAN(number)

The TAN function syntax has the following arguments:

- **Number** Required. The angle in radians for which you want the tangent.

Remark

If your argument is in degrees, multiply it by $\text{PI}()/180$ or use the RADIANS function to convert it to radians.
Example

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Formula	Description (Result)	Result
=TAN(0.785)	Tangent of 0.785 radians (0.99920)	0.99920
=TAN(45*PI()/180)	Tangent of 45 degrees (1)	1
=TAN(RADIANS(45))	Tangent of 45 degrees (1)	1

EXP function

Excel for Microsoft 365 Excel for Microsoft 365 for Mac Excel for the web Excel 2021 Excel 2021 for Mac Excel 2019 Excel 2019 for Mac Excel 2016 [More...](#)

This article describes the formula syntax and usage of the **EXP** function in Microsoft Excel.

Description

Returns e raised to the power of number. The constant e equals 2.71828182845904, the base of the natural logarithm.

Syntax

EXP(number)

The EXP function syntax has the following arguments:

- **Number** Required. The exponent applied to the base e.

Remarks

- To calculate powers of other bases, use the exponentiation operator (^).
- EXP is the inverse of LN, the natural logarithm of number.

Example

Copy the example data in the following table and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Formula	Description	Result
=EXP(1)	Approximate value of e	2.71828183
=EXP(2)	Base of the natural logarithm e raised to the power of 2	7.3890561

CONVERT function

Excel for Microsoft 365 Excel for Microsoft 365 for Mac Excel for the web [More...](#)

Converts a number from one measurement system to another. For example, CONVERT can translate a table of distances in miles to a table of distances in kilometers.

Syntax

CONVERT(number,from_unit,to_unit)

Number is the value in from_units to convert.

From_unit is the units for number.

To_unit is the units for the result. CONVERT accepts the following text values (in quotation marks) for from_unit and to_unit.

Measurement systems

Weight and Mass

Weight and mass	From_unit or to_unit
Gram	"g"
Slug	"sg"
Pound mass (avoirdupois)	"lbm"

Weight and mass	From_unit or to_unit
U (atomic mass unit)	"u"
Ounce mass (avoirdupois)	"ozm"
Grain	"grain"
U.S. (short) hundredweight	"cwt" or "shweight"
Imperial hundredweight	"uk_cwt" or "lcwt" ("hweight")
Stone	"stone"
Ton	"ton"
Imperial ton	"uk_ton" or "LTON" ("brton")

Distance

Distance	From_unit or to_unit
Meter	"m"
Statute mile	"mi"
Nautical mile	"Nmi"
Inch	"in"
Foot	"ft"

Distance	From_unit or to_unit
Yard	"yd"
Angstrom	"ang"
Ell	"ell"
Light-year	"ly"
Parsec	"parsec" or "pc"
Pica (1/72 inch)	"Picapt" or "Pica"
Pica (1/6 inch)	"pica"
U.S survey mile (statute mile)	"survey_mi"

Time

Time	From_unit or to_unit
Year	"yr"
Day	"day" or "d"
Hour	"hr"
Minute	"mn" or "min"
Second	"sec" or "s"

Pressure

Pressure	From_unit or to_unit
Pascal	"Pa" (or "p")
Atmosphere	"atm" (or "at")
mm of Mercury	"mmHg"
PSI	"psi"
Torr	"Torr"

Force

Force	From_unit or to_unit
Newton	"N"
Dyne	"dyn" (or "dy")
Pound force	"lbf"
Pond	"pond"

Energy

Energy	From_unit or to_unit
Joule	"J"
Erg	"e"

Energy	From_unit or to_unit
Thermodynamic calorie	"c"
IT calorie	"cal"
Electron volt	"eV" (or "ev")
Horsepower-hour	"HPh" (or "hh")
Watt-hour	"Wh" (or "wh")
Foot-pound	"flb"
BTU	"BTU" (or "btu")

Power

Power	From_unit or to_unit
Horsepower	"HP" (or "h")
Pferdestärke	"PS"
Watt	"W" (or "w")

Magnetism

Magnetism	From_unit or to_unit
Tesla	"T"

Magnetism	From_unit or to_unit
Gauss	"ga"

Temperature

Temperature	From_unit or to_unit
Degree Celsius	"C" (or "cel")
Degree Fahrenheit	"F" (or "fah")
Kelvin	"K" (or "kel")
Degrees Rankine	"Rank"
Degrees Réaumur	"Reau"

Volume

Volume (or liquid measure)	From_unit or to_unit
Teaspoon	"tsp"
Modern teaspoon	"tspm"
Tablespoon	"tbs"
Fluid ounce	"oz"
Cup	"cup"

Volume (or liquid measure)	From_unit or to_unit
U.S. pint	"pt" (or "us_pt")
U.K. pint	"uk_pt"
Quart	"qt"
Imperial quart (U.K.)	"uk_qt"
Gallon	"gal"
Imperial gallon (U.K.)	"uk_gal"
Liter	"l" or "L" ("lt")
Cubic angstrom	"ang ³ " or "ang^3"
U.S. oil barrel	"barrel"
U.S. bushel	"bushel"
Cubic feet	"ft ³ " or "ft^3"
Cubic inch	"in ³ " or "in^3"
Cubic light-year	"ly ³ " or "ly^3"
Cubic meter	"m ³ " or "m^3"
Cubic Mile	"mi ³ " or "mi^3"

Volume (or liquid measure)	From_unit or to_unit
Cubic yard	"yd3" or "yd^3"
Cubic nautical mile	"Nmi3" or "Nmi^3"
Cubic Pica	"Picapt3", "Picapt^3", "Pica3" or "Pica^3"
Gross Registered Ton	"GRT" ("regton")
Measurement ton (freight ton)	"MTON"

Area

Area	From_unit or to_unit
International acre	"uk_acre"
U.S. survey/statute acre	"us_acre"
Square angstrom	"ang2" or "ang^2"
Are	"ar"
Square feet	"ft2" or "ft^2"
Hectare	"ha"
Square inches	"in2" or "in^2"
Square light-year	"ly2" or "ly^2"

Area	From_unit or to_unit
Square meters	"m2" or "m^2"
Morgen	"Morgen"
Square miles	"mi2" or "mi^2"
Square nautical miles	"Nmi2" or "Nmi^2"
Square Pica	"Picapt2", "Pica2", "Pica^2" or "Picapt^2"
Square yards	"yd2" or "yd^2"

Information

Information	From_unit or to_unit
Bit	"bit"
Byte	"byte"

Speed

Speed	From_unit or to_unit
Admiralty knot	"admkn"
Knot	"kn"
Meters per hour	"m/h" or "m/hr"

Speed	From_unit or to_unit
Meters per second	"m/s" or "m/sec"
Miles per hour	"mph"

The following abbreviated unit prefixes can be prepended to any metric from_unit or to_unit.

Prefix	Multiplier	Abbreviation
yotta	1E+24	"Y"
zetta	1E+21	"Z"
exa	1E+18	"E"
peta	1E+15	"P"
tera	1E+12	"T"
giga	1E+09	"G"
mega	1E+06	"M"
kilo	1E+03	"k"
hecto	1E+02	"h"
dekao	1E+01	"da" or "e"
deci	1E-01	"d"

Prefix	Multiplier	Abbreviation
centi	1E-02	"c"
milli	1E-03	"m"
micro	1E-06	"u"
nano	1E-09	"n"
pico	1E-12	"p"
femto	1E-15	"f"
atto	1E-18	"a"
zepto	1E-21	"z"
yocto	1E-24	"y"

Binary Prefix	Prefix Value	Abbreviation	Derived from
yobi	$2^{80} = 1\ 208\ 925\ 819\ 614\ 629\ 174\ 706\ 176$	"Yi"	yotta
zebi	$2^{70} = 1\ 180\ 591\ 620\ 717\ 411\ 303\ 424$	"Zi"	zetta
exbi	$2^{60} = 1\ 152\ 921\ 504\ 606\ 846\ 976$	"Ei"	exa
pebi	$2^{50} = 1\ 125\ 899\ 906\ 842\ 624$	"Pi"	peta

Binary Prefix	Prefix Value	Abbreviation	Derived from
tebi	$2^{40} = 1\,099\,511\,627\,776$	"Ti"	tera
gibi	$2^{30} = 1\,073\,741\,824$	"Gi"	giga
mebi	$2^{20} = 1\,048\,576$	"Mi"	mega
kibi	$2^{10} = 1024$	"ki"	kilo

Remarks

- If the input data types are incorrect, CONVERT returns the #VALUE! error value.
- If the unit does not exist, CONVERT returns the #N/A error value.
- If the unit does not support a binary prefix, CONVERT returns the #N/A error value.
- If the units are in different groups, CONVERT returns the #N/A error value.
- Unit names and prefixes are case-sensitive.

Examples

This is an example of how a formula uses CONVERT.

Formula	Description	Result
=CONVERT(1, "lbm", "kg")	Converts 1 pound mass to kilograms.	0.4535924
=CONVERT(68, "F", "C")	Converts 68 degrees Fahrenheit to Celsius.	20
=CONVERT(2.5, "ft", "sec")	Data types are not the	#N/A

Formula	Description	Result
	same, so an error is returned.	
=CONVERT(CONVERT(100,"ft","m"),"ft","m")	Converts 100 square feet into square meters.	9.290304

You can see how CONVERT works in Excel. Copy the following table (starting with the "6") and paste it to a blank Excel worksheet, placing the "6" in cell A1.

6

Formula	Description (Result)
=CONVERT(A1,"C","F")	Convert 6 degrees Celsius to Fahrenheit (42.8)
=CONVERT(A1,"tsp","tbs")	Convert 6 teaspoons to tablespoons (2)
=CONVERT(A1,"gal","l")	Convert 6 gallons to liters (22.71741274)
=CONVERT(A1,"mi","km")	Convert 6 miles to kilometers (9.656064)
=CONVERT(A1,"km","mi")	Convert 6 kilometers to miles (3.728227153)
=CONVERT(A1,"in","ft")	Convert 6 inches to feet (0.5)

=CONVERT(A1,"cm","in") Convert 6 centimeters to inches
(2.362204724)

EXPERIMENT-3

Date:

Aim: Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.

Using IF with AND, OR and NOT functions

Excel for Microsoft 365 Excel for Microsoft 365 for Mac [More...](#)

Spread Sheet for Engineers

The IF function allows you to make a logical comparison between a value and what you expect by testing for a condition and returning a result if that condition is True or False.

- =IF(Something is True, then do something, otherwise do something else)

But what if you need to test multiple conditions, where let's say all conditions need to be True or False (**AND**), or only one condition needs to be True or False (**OR**), or if you want to check if a condition does **NOT** meet your criteria? All 3 functions can be used on their own, but it's much more common to see them paired with IF functions.

Technical Details

Here are overviews of how to structure [AND](#), [OR](#) and [NOT](#) functions individually. When you combine each one of them with an IF statement, they read like this:

- **AND** – =IF(AND(Something is True, Something else is True), Value if True, Value if False)
- **OR** – =IF(OR(Something is True, Something else is True), Value if True, Value if False)
- **NOT** – =IF(NOT(Something is True), Value if True, Value if False)

Examples

Following are examples of some common nested IF(AND()), IF(OR()) and IF(NOT()) statements. The AND and OR functions can support up to 255 individual conditions, but it's not good practice to use more than a few because complex, nested formulas can get very difficult to build, test and maintain. The NOT function only takes one condition.

	A	B	C	D
1	Value 1	Value 2	IF/AND/OR/NOT	Formula
2	25	75	TRUE	=IF(AND(A2>0,B2<100),TRUE, FALSE)
3	Blue	Green	FALSE	=IF(AND(A3="Red",B3="Green"),TRUE,FALSE)
4	25	75	TRUE	=IF(OR(A4>0,B4<50),TRUE, FALSE)
5	Blue	Green	TRUE	=IF(OR(A5="Red",B5="Green"),TRUE,FALSE)
6	25		TRUE	=IF(NOT(A6>50),TRUE,FALSE)
7	Blue		TRUE	=IF(NOT(A7="Red"),TRUE,FALSE)

Here are the formulas spelled out according to their logic:

Formula	Description
=IF(AND(A2>0,B2<100),TRUE, FALSE)	IF A2 (25) is greater than 0, AND B2 (75) is less than 100, then return TRUE, otherwise return FALSE. In this case both conditions are true, so TRUE is returned.
=IF(AND(A3="Red",B3="Green"),TRUE,FALSE)	If A3 ("Blue") = "Red", AND B3 ("Green") equals "Green" then

Formula	Description
=IF(OR(A4>0,B4<50),TRUE, FALSE)	return TRUE, otherwise return FALSE. In this case only the first condition is true, so FALSE is returned.
=IF(OR(A5="Red",B5="Green"),TRUE,FALSE)	IF A4 (25) is greater than 0, OR B4 (75) is less than 50, then return TRUE, otherwise return FALSE. In this case, only the first condition is TRUE, but since OR only requires one argument to be true the formula returns TRUE.
=IF(NOT(A6>50),TRUE,FALSE)	IF A5 (“Blue”) equals “Red”, OR B5 (“Green”) equals “Green” then return TRUE, otherwise return FALSE. In this case, the second argument is True, so the formula returns TRUE.
=IF(NOT(A7="Red"),TRUE,FALSE)	IF A6 (25) is NOT greater than 50, then return TRUE, otherwise return FALSE. In this case 25 is not greater than 50, so the formula returns TRUE.
	IF A7 (“Blue”) is NOT equal to “Red”, then return TRUE, otherwise return FALSE.

Note that all of the examples have a closing parenthesis after their respective conditions are entered. The remaining True/False arguments are then left as part of the outer IF statement. You can also substitute Text or Numeric values for the TRUE/FALSE values to be returned in the examples.

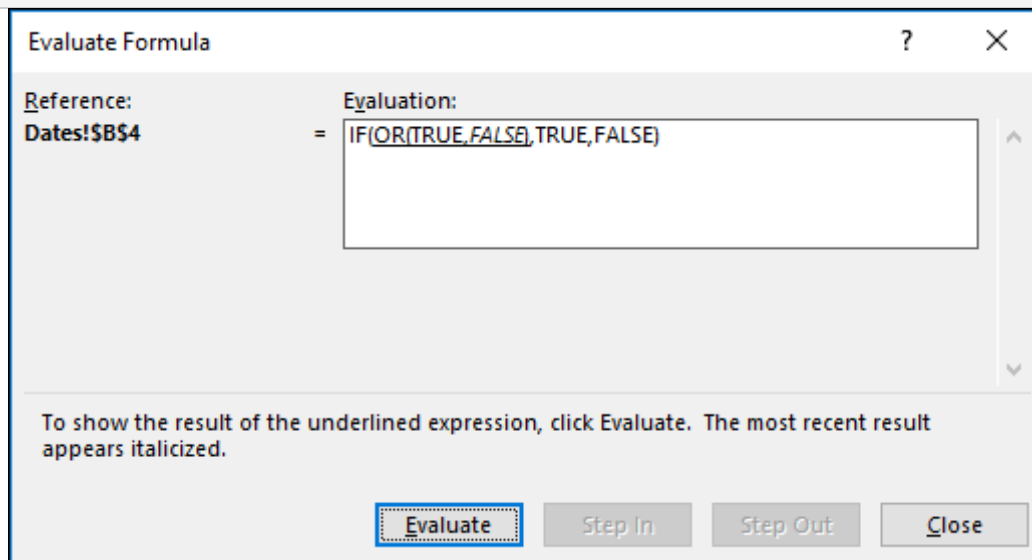
Here are some examples of using AND, OR and NOT to evaluate dates.

	A	B	C	D	E
				IF/AND/ OR/NOT	Formula
1	Start Date	Date 1	Date 2	TRUE	=IF(A2>B2,TRUE,FALSE)
2	03/12/14	01/01/14	12/31/14	TRUE	=IF(AND(A3>B2,A3<C2),TRUE,FALSE)
3	03/12/14			TRUE	=IF(OR(A4>B2,A4<B2+60),TRUE,FALSE)
4	03/12/14			FALSE	=IF(NOT(A5>B2),TRUE,FALSE)
5	03/12/14				

Here are the formulas spelled out according to their logic:

Formula	Description
---------	-------------

Formula	Description
=IF(A2>B2,TRUE,FALSE)	IF A2 is greater than B2, return TRUE, otherwise return FALSE. 03/12/14 is greater than 01/01/14, so the formula returns TRUE.
=IF(AND(A3>B2,A3<C2),TRUE,FALSE)	IF A3 is greater than B2 AND A3 is less than C2, return TRUE, otherwise return FALSE. In this case both arguments are true, so the formula returns TRUE.
=IF(OR(A4>B2,A4<B2+60),TRUE,FALSE)	IF A4 is greater than B2 OR A4 is less than B2 + 60, return TRUE, otherwise return FALSE. In this case the first argument is true, but the second is false. Since OR only needs one of the arguments to be true, the formula returns TRUE. If you use the Evaluate Formula Wizard from the Formula tab you'll see how Excel evaluates the formula.
=IF(NOT(A5>B2),TRUE,FALSE)	IF A5 is not greater than B2, then return TRUE, otherwise return FALSE. In this case, A5 is greater than B2, so the formula returns FALSE.



IF function

The IF function is one of the most popular functions in Excel, and it allows you to make logical comparisons between a value and what you expect.

So an IF statement can have two results. The first result is if your comparison is True, the second if your comparison is False.

For example, =IF(C2="Yes",1,2) says IF(C2 = Yes, then return a 1, otherwise return a 2).

Syntax

Simple IF examples

fx		=IF(C2="Yes",1,2)	
C	D		
Active?	Activity Code		
Yes	1		

- =IF(C2="Yes",1,2)

In the above example, cell D2 says: IF(C2 = Yes, then return a 1, otherwise return a 2)

fx		=IF(C2=1,"Yes","No")	
C	D		
Active?	Activity Code		
1	Yes		

- =IF(C2=1,"Yes","No")

In this example, the formula in cell D2 says: IF(C2 = 1, then return Yes, otherwise return No)As you see, the IF function can be used to evaluate both text and values. It can also be used to [evaluate errors](#). You are not limited to only checking if one thing is equal to another and returning a single result, you can also use mathematical operators and perform additional calculations depending on your criteria. You can also nest multiple IF functions together in order to perform multiple comparisons.

fx		=IF(C2>B2,"Over Budget", "Within Budget")		
B	C	D	E	
Budgeted	Actual	Status	Amount Over	
\$800.00	\$921.58	Over Budget	\$121.58	
\$375.00	\$324.98	Within Budget	\$0.00	
\$150.00	\$128.43	Within Budget	\$0.00	
\$150.00	\$174.38	Over Budget	\$24.38	

- =IF(C2>B2,"Over Budget","Within Budget")

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In the above example, the IF function in D2 is saying *IF(C2 Is Greater Than B2, then return “Over Budget”, otherwise return “Within Budget”)*

B	C	D	E
Budgeted	Actual	Status	Amount Over
\$800.00	\$921.58	Over Budget	\$121.58
\$375.00	\$324.98	Within Budget	\$0.00
\$150.00	\$128.43	Within Budget	\$0.00
\$150.00	\$174.38	Over Budget	\$24.38

- =IF(C2>B2,C2-B2,0)

In the above illustration, instead of returning a text result, we are going to return a mathematical calculation. So the formula in E2 is saying *IF(Actual is Greater than Budgeted, then Subtract the Budgeted amount from the Actual amount, otherwise return nothing).*

C	D	E	F
Item	Quantity	Cost	Total
Widget	2	\$2.90	\$5.80
Doohickey	3	\$8.55	\$25.66
	Sub-Total	\$11.45	\$31.46
	Sales Tax?	Yes	\$2.60
	Total		\$34.05

- =IF(E7="Yes",F5*0.0825,0)

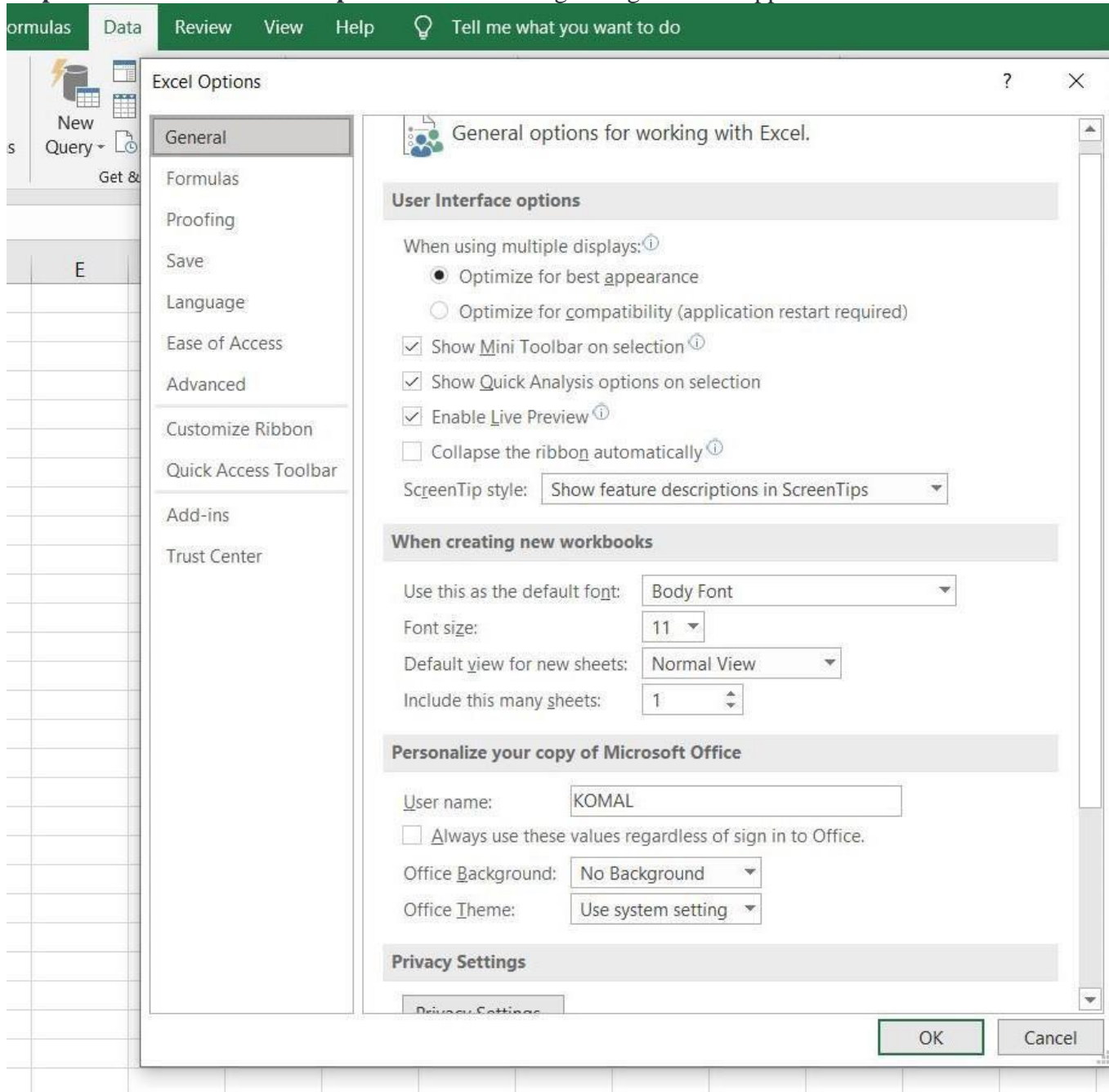
In this example, the formula in F7 is saying *IF(E7 = “Yes”, then calculate the Total Amount in F5 * 8.25%, otherwise no Sales Tax is due so return 0)*

Solver:

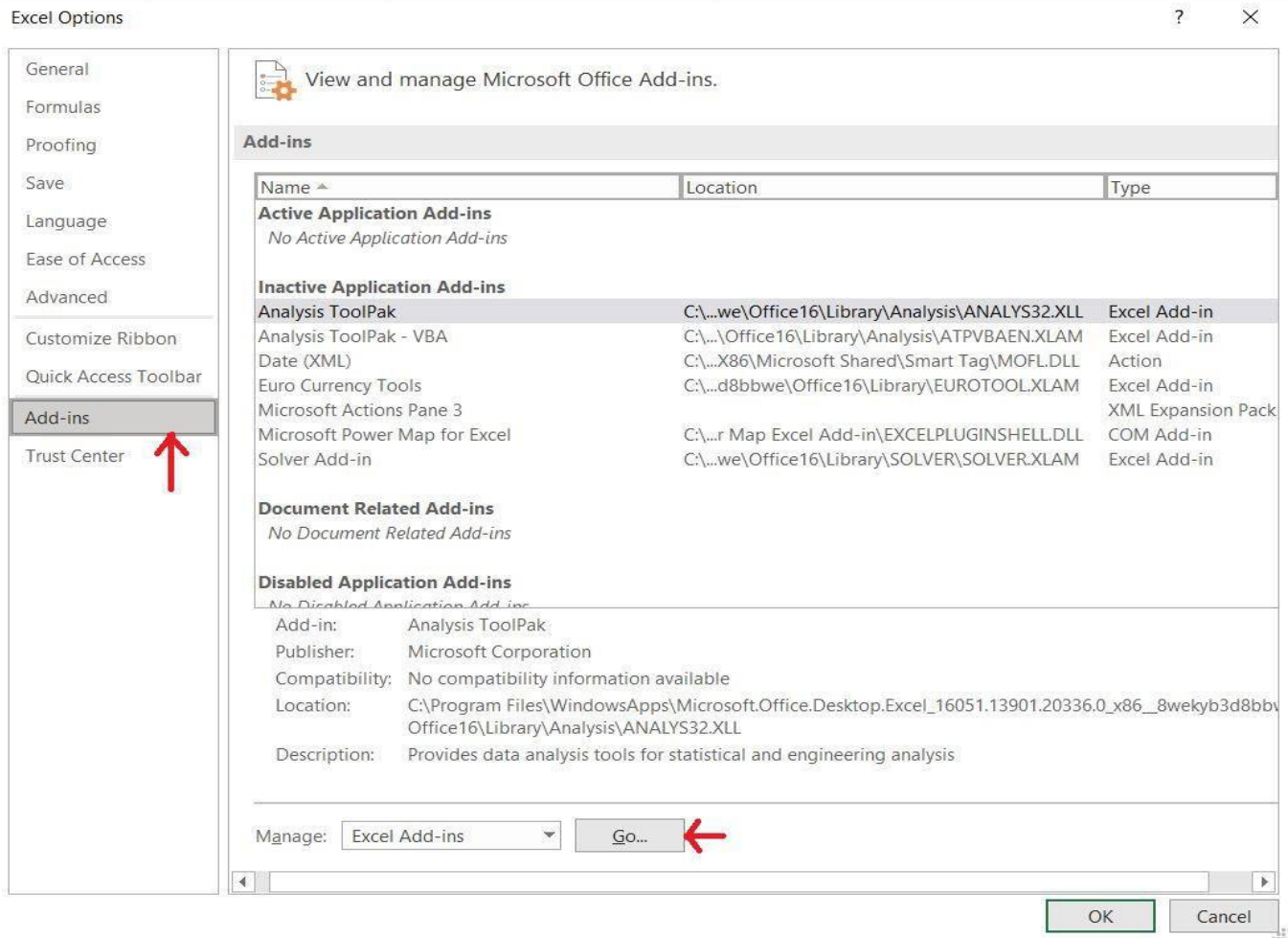
A solver is a mathematical tool present in MS-Excel that is used to perform calculations by working under some constraints/conditions and then calculates the solution for the problem. It works on the objective cell by changing the variable cells any by using sum constraints.

Solver is present in MS- Excel but for using it we need to activate it. For activating the solver tool we need to do the following steps:

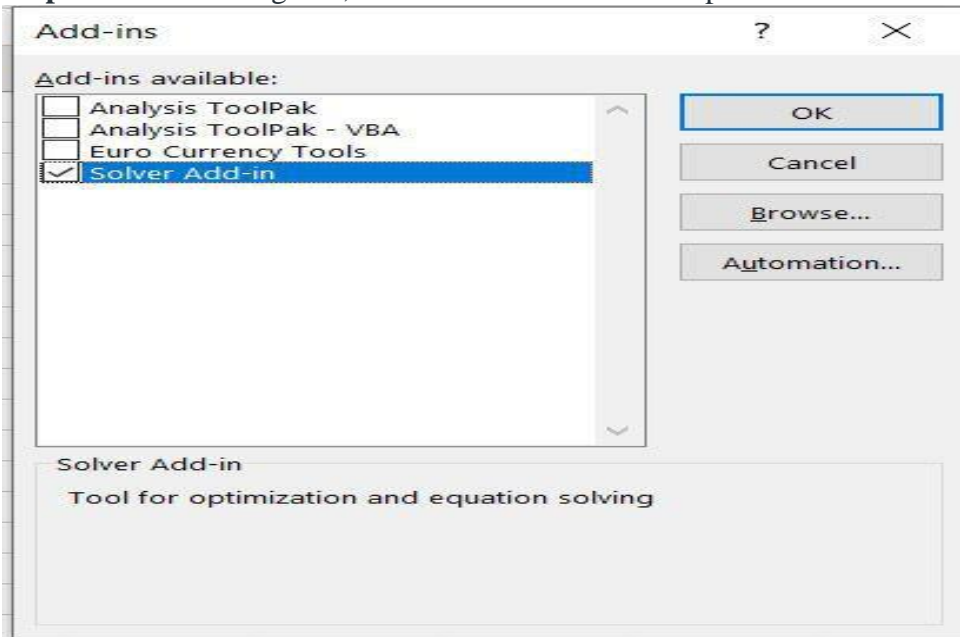
Step 1: Go to **File** and select **options**. The following dialog box will appear.



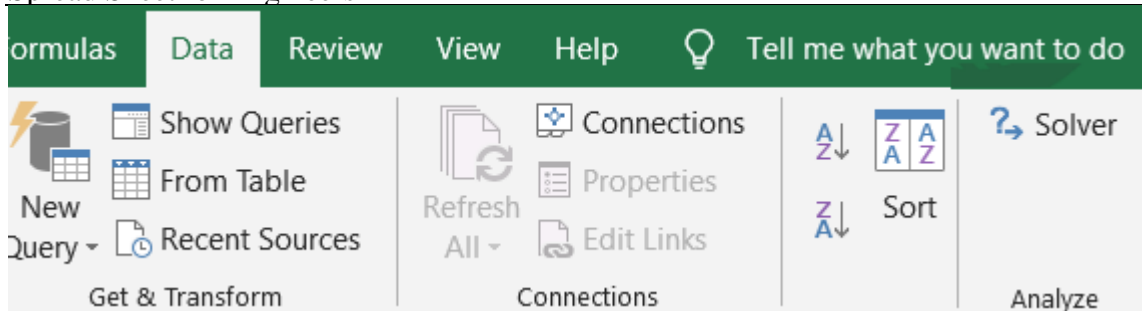
Step 2: Now select the **Add-ins** option and click on **Go** and finally click on **OK**.



Step 3: After clicking OK, Select **Solver Add-in** and press **OK**. Now solver will be activated in Excel.



Step 4: Now solver will appear in **data section** like this.



Now let's understand how to use solver with the help of an example.

Example:

We went to a mall and we also have a gift voucher worth rs.10,000 and We want to purchase items in such a manner that all the money of the gift voucher gets utilized.

So, suppose we purchased the following items.

	A	B	C	D	E
1	Items	Quantity	Price	Total	
2	Iron	1	700	700	
3	Mobile	1	5000	5000	
4	Headphones	1	400	400	
5	kettle	1	900	900	
6	watch	1	2300	2300	
7		5		9300	
8					
9					
10					
11		Voucher=	10000		
12					
13					

Suppose we purchased the above items in only one quantity and the total came out to be 9300 but the voucher was for rs.10,000. So now we want to use Solver for this purpose. Now let's see how it will be done.

Step 1: Firstly go on data and find solver there and click it. The following dialog box will appear. Now in this, we have to select the objective in which we want to change our value.

Spread Sheet for Engineers

Solver Parameters

Set Objective:

To: Max Min Value Of:

By Changing Variable Cells:

Subject to the Constraints:

Make Unconstrained Variables Non-Negative

Select a Solving Method: GRG Nonlinear

Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Step 2: In the set objective we have to select the total of the D column because we want the value to change from 9300 to 10,000. After clicking on D7 following thing will be displayed on the set objective block.

Solver Parameters

Set Objective:

To: Max Min Value Of:

By Changing Variable Cells:

Subject to the Constraints:

Make Unconstrained Variables Non-Negative

Select a Solving Method: GRG Nonlinear

Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Step 3: Now in the 'By changing Variable cell' we will select the Quantity cell because we want to change the quantity in such a way so that the total amount comes to 10,000.

Spread Sheet for Engineers

Quantity	Price
1	
1	
1	
1	
1	
5	

Voucher=

Solver Parameters

Set Objective: ↑

To: Max Min Value Of:

By Changing Variable Cells: ↑

Subject to the Constraints:

Make Unconstrained Variables Non-Negative

Select a Solving Method: ▼

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Step 5– Now, a dialog box will appear and we will add 3 conditions. The first condition is that the total amount should be equal to the voucher amount. So we will select cell D7 in a cell reference and then = sign, and finally, we will select cell C11. Now the first condition is added. To add the next condition press Add.

	A	B	C	D	E	F	G	H	I	J	K
1	Items	Quantity	Price	Total							
2	Iron	1	700	700							
3	Mobile	1	5000	5000							
4	Headphones	1	400	400							
5	kettle	1	900	900							
6	watch	1	2300	2300							
7		5		9300							
8											
9											
10											
11		Voucher=	10000								

Add Constraint

Cell Reference: ↑ = ▼ Constraint: ↑

Step 6: For the second condition we will select the Quantity cell because we want the quantity to be an integer value, a whole value. So in cell reference, we will select from B2 to B6 then **int**, and then again will press Add.

Spread Sheet for Engineers

	A	B	C	D	E	F	G	H	I	J	K
1	Items	Quantity	Price	Total							
2	Iron	1	700	700							
3	Mobile	1	5000	5000							
4	Headphones	1	400	400							
5	kettle	1	900	900							
6	watch	1	2300	2300							
7		5		9300							
8											
9											
10											
11		Voucher=	10000								

Add Constraint ✕

Cell Reference: Constraint:

Step 7- Now for the third condition, we want that our item quantity should never be an negative which is not possible in real life. So we will select cells from B2 to B6 and should be \geq to zero. Then click Add and cancel.

	A	B	C	D	E	F	G	H	I	J	K
1	Items	Quantity	Price	Total							
2	Iron	1	700	700							
3	Mobile	1	5000	5000							
4	Headphones	1	400	400							
5	kettle	1	900	900							
6	watch	1	2300	2300							
7		5		9300							
8											
9											
10											
11		Voucher=	10000								

Add Constraint ✕

Cell Reference: Constraint:

Step 8: Now the following dialog box will show all the 3 conditions that we used and now click on Solve.

Solver Parameters

Set Objective:

To: Max Min Value Of:

By Changing Variable Cells:

Subject to the Constraints:

Make Unconstrained Variables Non-Negative

Select a Solving Method:

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Step 9: By clicking Solve the solver will provide the desired output and to keep the answer we will click on keep solver solution.

Spread Sheet for Engineers

	A	B	C	D
1	Items	Quantity	Price	Total
2	Iron	0	700	0
3	Mobile	2	5000	10000
4	Headphones	0	400	0
5	kettle	0	900	0
6	watch	0	2300	0
7		2		10000
8				
9				
10				
11		Voucher=	10000	
12				
13				
14				
15				
16				
17				
18				

Solver Results

Solver found an integer solution within tolerance. All Constraints are satisfied.

Keep Solver Solution
 Restore Original Values

Return to Solver Parameters Dialog
 Outline Reports

Solver found an integer solution within tolerance. All Constraints are satisfied.

It is possible that better integer solutions exist. To make sure Solver finds the very best integer tolerance in the options dialog to 0%.

So, this is what a solver is, How it is activated by not by default present in Excel and this is how it is used.

How to get started

There are four pieces of information that you will need in order to build the VLOOKUP syntax:

1. The value you want to look up, also called the lookup value.
2. The range where the lookup value is located. Remember that the lookup value should always be in the first column in the range for VLOOKUP to work correctly. For example, if your lookup value is in cell C2 then your range should start with C.
3. The column number in the range that contains the return value. For example, if you specify B2:D11 as the range, you should count B as the first column, C as the second, and so on.
4. Optionally, you can specify TRUE if you want an approximate match or FALSE if you want an exact match of the return value. If you don't specify anything, the default value will always be TRUE or approximate match.

Now put all of the above together as follows:

=VLOOKUP(lookup value, range containing the lookup value, the column number in the range containing the return value, Approximate match (TRUE) or Exact match (FALSE)).

Examples

Here are a few examples of VLOOKUP:

Example 1

	A	B	C	D	E
1	ID	Last name	First name	Title	Birth date
2	101	Davis	Sara	Sales Rep	12/08/68
3	102	Fontana	Olivier	VP (Sales)	02/19/52
4	103	Leal	Karina	Sales Rep	08/30/63
5	104	Patten	Michael	Sales Rep	09/19/58
6	105	Burke	Brian	Sales Manager	03/04/55
7	106	Sousa	Luis	Sales Rep	07/02/63
8					
9					
10	Formula	=VLOOKUP(B3,B2:E7,2,FALSE)			
11	Result	Olivier			
12					

VLOOKUP looks for *Fontana* in the first column (column B) in table_array B2:E7, and returns *Olivier* from the second column (column C) of the table_array. FALSE returns an exact match.

Example 2

	A	B	C	D	E
1	ID	Last name	First name	Title	Birth date
2	101	Davis	Sara	Sales Rep	12/08/68
3	102	Fontana	Olivier	VP (Sales)	02/19/52
4	103	Leal	Karina	Sales Rep	08/30/63
5	104	Patten	Michael	Sales Rep	09/19/58
6	105	Burke	Brian	Sales Manager	03/04/55
7	106	Sousa	Luis	Sales Rep	07/02/63
8					
9					
10	Formula	=VLOOKUP(102,A2:C7,2,FALSE)			
11	Result	Fontana			

VLOOKUP looks for an exact match (FALSE) of the last name for 102 (lookup_value) in the second column (column B) in the A2:C7 range, and returns *Fontana*.

Example 3

Spread Sheet for Engineers

	A	B	C	D	E
1	ID	Last name	First name	Title	Birth date
2	101	Davis	Sara	Sales Rep	12/08/68
3	102	Fontana	Olivier	VP (Sales)	02/19/52
4	103	Leal	Karina	Sales Rep	08/30/63
5	104	Patten	Michael	Sales Rep	09/19/58
6	105	Burke	Brian	Sales Manager	03/04/55
7	106	Sousa	Luis	Sales Rep	07/02/63
8		IF checks to see if VLOOKUP returns <i>Sousa</i> as the last name of employee corresponding to 103 (lookup_value) in A1:E7 (table_array). Because the last name corresponding to 103 is <i>Leal</i> , the IF condition is false, and <i>Not found</i> is displayed.			
9					
10	Formula	=IF(VLOOKUP(103,A1:E7,2,FALSE)="Sousa","Located","Not found")			
11	Result	Not found			

Example 4

	A	B	C	D	E
1	ID	Last name	First name	Title	Birth date
2	101	Davis	Sara	Sales Rep	12/08/68
3	102	Fontana	Olivier	VP (Sales)	02/19/52
4	103	Leal	Karina	Sales Rep	08/30/63
5	104	Patten	Michael	Sales Rep	09/19/58
6	105	Burke	Brian	Sales Manager	03/04/55
7	106	Sousa	Luis	Sales Rep	07/02/63
8					
9					
10	Formula	=INT(YEARFRAC(DATE(2014,6,30), VLOOKUP(105,A2:E7,5, FALSE), 1))			
11	Result	59			
12		VLOOKUP looks for the birth date of the employee corresponding to 105 (lookup_value) in the A2:E7 range (table_array), and returns 03/04/1955. Then, YEARFRAC subtracts this birth date from 2014/6/30 and returns a value, which is then converted by INT to the integer 59.			
13					
14					
15					

Example 5

	A	B	C	D	E
1	ID	Last name	First name	Title	Birth date
2	101	Davis	Sara	Sales Rep	12/08/68
3	102	Fontana	Olivier	VP (Sales)	02/19/52
4	103	Leal	Karina	Sales Rep	08/30/63
5	104	Patten	Michael	Sales Rep	09/19/58
6	105	Burke	Brian	Sales Manager	03/04/55
7	106	Sousa	Luis	Sales Rep	07/02/63
8					
9					
10	Formula	=IF(ISNA(VLOOKUP(105,A2:E7,2,FALSE)) = TRUE, "Employee not found", VLOOKUP(105,A2:E7,2,FALSE))			
11	Result	Burke			
12		<p>IF checks to see if VLOOKUP returns a value for last name from column B for 105 (lookup_value). If VLOOKUP finds a last name, then IF will display the last name, otherwise IF returns <i>Employee not found</i>. ISNA makes sure that if VLOOKUP returns #N/A, then the error is replaced by <i>Employee not found</i>, instead of #N/A.</p> <p>In this example, the return value is <i>Burke</i>, which is the last name corresponding to 105.</p>			
13					
14					

XOR function

Excel for Microsoft 365 Excel for Microsoft 365 for Mac [More...](#)

The **XOR** function returns a logical **Exclusive Or** of all arguments.

Syntax

XOR(logical1, [logical2],...)

The XOR function syntax has the following arguments.

- **Logical1, logical2,...** Logical 1 is required, subsequent logical values are optional. 1 to 254 conditions you want to test that can be either TRUE or FALSE, and can be logical values, arrays, or references.

Remarks

- The arguments must evaluate to logical values such as TRUE or FALSE, or in arrays or references that contain logical values.
- If an array or reference argument contains text or empty cells, those values are ignored.
- If the specified range contains no logical values, XOR returns the #VALUE! error value.
- You can use an XOR array formula to see if a value occurs in an array.

Note: If you have a current version of [Microsoft 365](#), then you can simply enter the formula in the top-left-cell of the output range, then press **ENTER** to confirm the formula as a dynamic array formula. Otherwise, the formula must be entered as a legacy array formula by first selecting the output range, entering the formula in the top-left-cell of the output range, and then pressing **CTRL+SHIFT+ENTER** to confirm it. Excel inserts curly brackets at the beginning and end of the formula for you. For more information on array formulas, see [Guidelines and examples of array formulas](#).

- The result of XOR is TRUE when the number of TRUE inputs is odd and FALSE when the number of TRUE inputs is even.

Example

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter.

Formula	Description	Result
=XOR(3>0,2<9)	Because both of the two tests evaluates to TRUE, FALSE is returned.	FALSE
=XOR(3>12,4>6)	Because all test results evaluate to FALSE, FALSE is returned. At least one of the test results must evaluate to TRUE to return TRUE.	FALSE

AND function

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Use the **AND** function, one of the [logical functions](#), to determine if all conditions in a test are TRUE.

Example

	A	B	C
1	Formula	Description	Result
2	=AND(TRUE,TRUE)	All arguments are TRUE	TRUE
3	=AND(TRUE,FALSE)	One argument is FALSE	FALSE
4	=AND(1=1,2=2,3=3)	All arguments are TRUE	TRUE
5	=AND(1=2,2=3,3=4)	One argument is FALSE	FALSE

Technical Details

Examples

Here are some general examples of using **AND** by itself, and in conjunction with the **IF** function.

	A	B	C	D	E
1	Values				
2	50				
3	100				
4					
5	Formula	Result			Result
6	=AND(A2>1,A2<100)				TRUE
7	=IF(AND(A2<A3,A2<100),A2,"The value is out of range")				50
8	=IF(AND(A3>1,A3<100),A3,"The value is out of range")				The value is out of range

Formula	Description
=AND(A2>1,A2<100)	Displays TRUE if A2 is greater than 1 AND less than 100, otherwise it displays FALSE.
=IF(AND(A2<A3,A2<100),A2,"The value is out of range")	Displays the value in cell A2 if it's less than A3 AND less than 100, otherwise it displays the message "The value is out of range".
=IF(AND(A3>1,A3<100),A3,"The value is out of range")	Displays the value in cell A3 if it is greater than 1 AND less than 100, otherwise it displays a message. You can substitute any message of your choice.

Bonus Calculation

Here is a fairly common scenario where we need to calculate if sales people qualify for a bonus using **IF** and **AND**.

Spread Sheet for Engineers

Goals	
Criteria	Amount
Sales Goal:	\$8,500
Account Goal:	5
Commission Rate:	2.0%
Bonus Goal:	\$12,500
Bonus %:	1.5%

• Sales people need to exceed either Sales **OR** Account Goals to earn Commission
 • Sales people need to exceed both Sales **AND** Account Goals to earn Bonus

Comission Calculations with Conditions					
Salesperson	Total Sales	Accounts	Commission	Bonus	
Millicent Shelton	\$10,260	9	\$205		
Miguel Ferrari	\$15,700	7	\$314	\$236	
Claire Fox	\$13,275	5	\$266	\$199	
Rosemarie Cobb	\$9,100	3	\$182		
Lorie Chen	\$7,480	4			

- $=IF(AND(B14 >= \$B\$7, C14 >= \$B\$5), B14 * \$B\$8, 0)$ – **IF** Total Sales are greater than or equal ($>=$) to the Sales Goal, **AND** Accounts are greater than or equal ($>=$) the Account Goal, then multiply Total Sales by the Bonus %, otherwise return 0.

EXPERIMENT-4

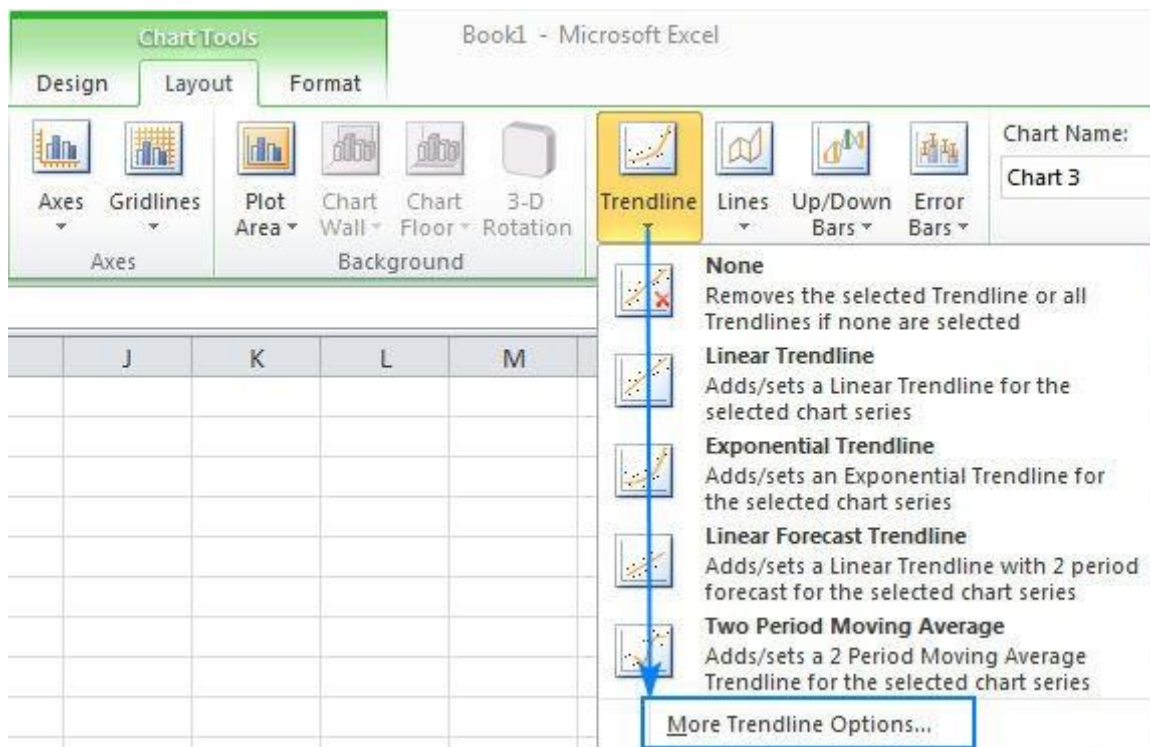
Date:

Aim: Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis Tool Pack.

How to make a trendline in Excel 2010

To add a trendline in Excel 2010, you follow a different route:

1. On a chart, click the data series for which you want to draw a trendline.
2. Under *Chart Tools*, go to the *Layout* tab > *Analysis* group, click **Trendline** and either:
 - o Pick one of the predefined options, or
 - o Click **More Trendline Options...**, and then choose the trendline type for your chart.



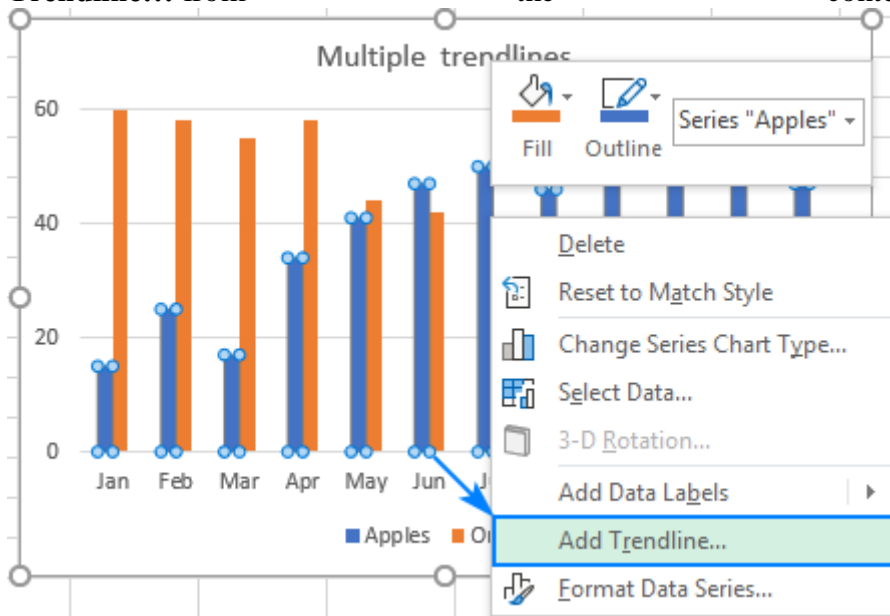
How to insert multiple trendlines in the same chart

Microsoft Excel allows adding more than one trendline to a chart. There are two scenarios that should be handled differently.

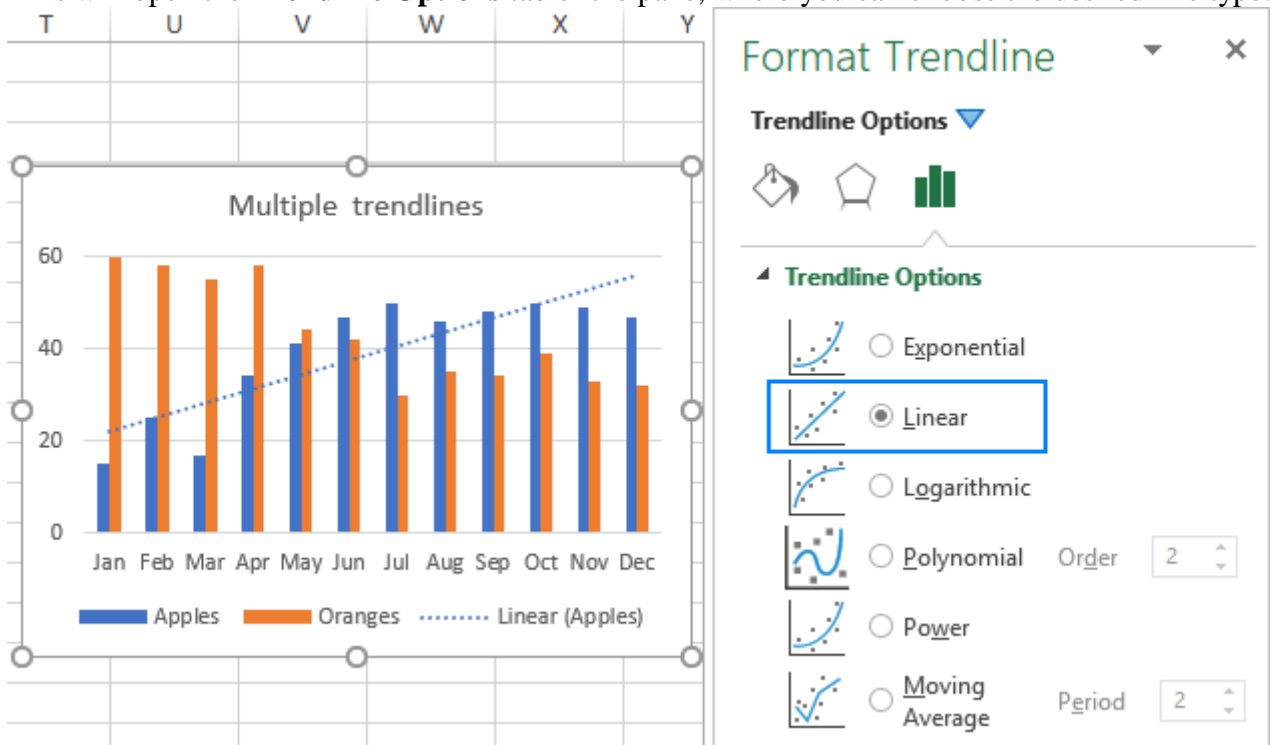
Add a trendline for each data series

To put a trendline on a chart that has two or more data series, here's what you do:

1. Right-click the data points of interest (blue ones in this example) and choose **Add Trendline...** from the context menu:

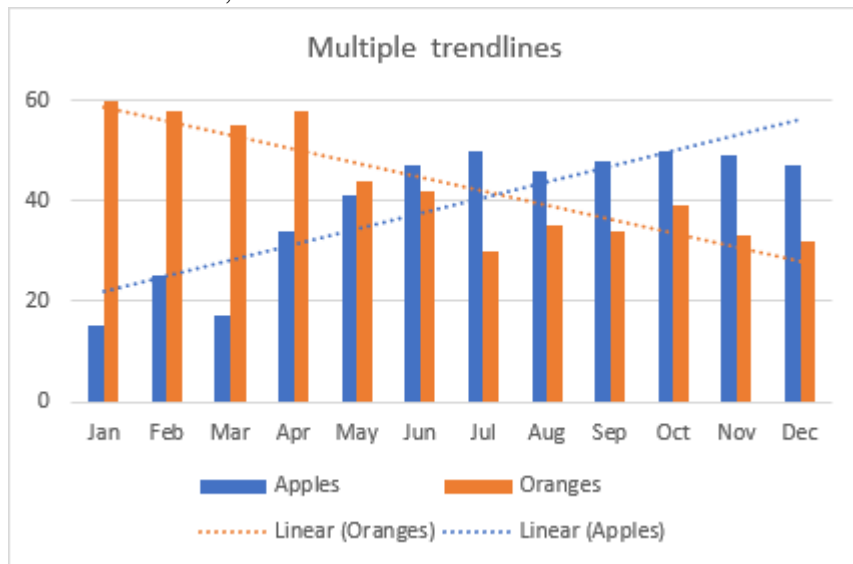


2. This will open the **Trendline Options** tab of the pane, where you can choose the desired line type:



3. Repeat the above steps for the other data series.

As the result, each data series will have its own trendline of the matching color:



Alternatively, you can click the *Chart Elements* button, then click the arrow next to **Trendline** and choose the type you want. Excel will show a list of the data series plotted in your chart. You pick the needed one and click *OK*.

Chart Elements

- Axes
- Axis Titles
- Chart Title
- Data Labels
- Data Table
- Error Bars
- Gridlines
- Legend
- Trendline

Add Trendline

Add a Trendline based on Series:

- Apples
- Oranges

OK Cancel

Forecasting is a special technique of making predictions for the future by using historical data as inputs and analyzing trends.

This method is commonly used to make educated guesses on cash flows, plan budgets, anticipate future expenses or sales, and so on. However, forecasting doesn't tell the future definitively, it only shows probabilities. So, you should always double check the results before making a decision.

Microsoft Excel offers a few different forecasting tools including built-in features, functions, and graphs. Depending in your needs, you can choose one of the following methods:

- [Exponential smoothing forecast](#) - time series forecasting based on historical data with seasonal or other cycles.
- [Linear forecast](#) - predicting future values using linear regression.

How to forecast in Excel using exponential smoothing

Exponential smoothing forecasting in Excel is based on the AAA version (additive error, additive trend and additive seasonality) of the *Exponential Triple Smoothing* (ETS) algorithm, which smoothes out minor deviations in past data trends by detecting seasonality patterns and confidence intervals.

This forecasting method is best suited for **non-linear** data models with seasonal or other **recurring patterns**. It is available in Excel 2016, Excel 2019 and Excel for Office 365.

You can do such a forecast with your own formulas or have Excel create a forecast sheet for you automatically.

Create an exponential forecast sheet automatically.

The **Forecast Sheet** feature introduced in Excel 2016 makes time series forecasting super-easy. Basically, you only need to appropriately organize the source data, and Excel will do the rest.

Arranging data

In your Excel worksheet, enter two data series into adjacent columns:

- Time series - date or time entries that are observed sequentially at a regular interval like hourly, daily, monthly, yearly, etc.
- Data values series - corresponding numeric values that will be predicted for future dates.

It is important that your time series have **equal intervals** between the data points. For example, you can supply weekly intervals with values on every Monday, monthly intervals with values on the 1st day of every month, etc.

Spread Sheet for Engineers

In theory, your time series can miss up to 30% of data points or have several entries with the same date or time, and Excel will still do the forecast correctly. However, it is recommended to summarize your data to get more accurate predictions.

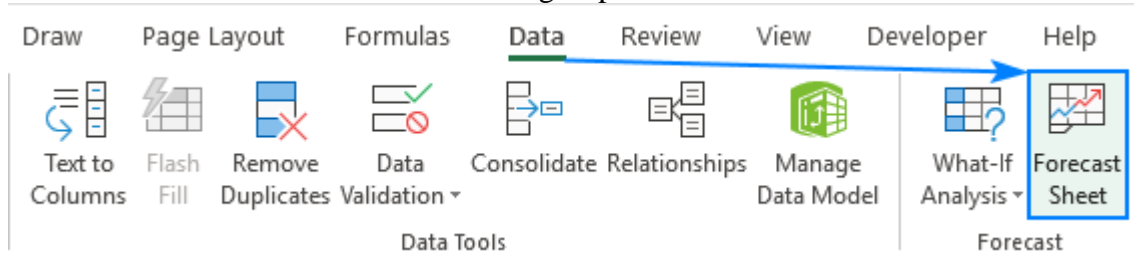
In this example, we will try to forecast sales for the next few years based on the following historical data. Please pay attention that column A contains dates (the 1st of every month) in a custom format that displays only the month and year. However, these are fully-functional dates, not text values.

	A	B
1	Month	Sales
2	Jan, 2017	\$3,200
3	Feb, 2017	\$2,700
4	Mar, 2017	\$2,900
5	Apr, 2017	\$3,400
6	May, 2017	\$3,700
7	Jun, 2017	\$3,900
8	Jul, 2017	\$4,100
9	Aug, 2017	\$4,150
10	Sep, 2017	\$3,800
11	Oct, 2017	\$3,750
12	Nov, 2017	\$3,700
13	Dec, 2017	\$3,800

Creating a forecast sheet

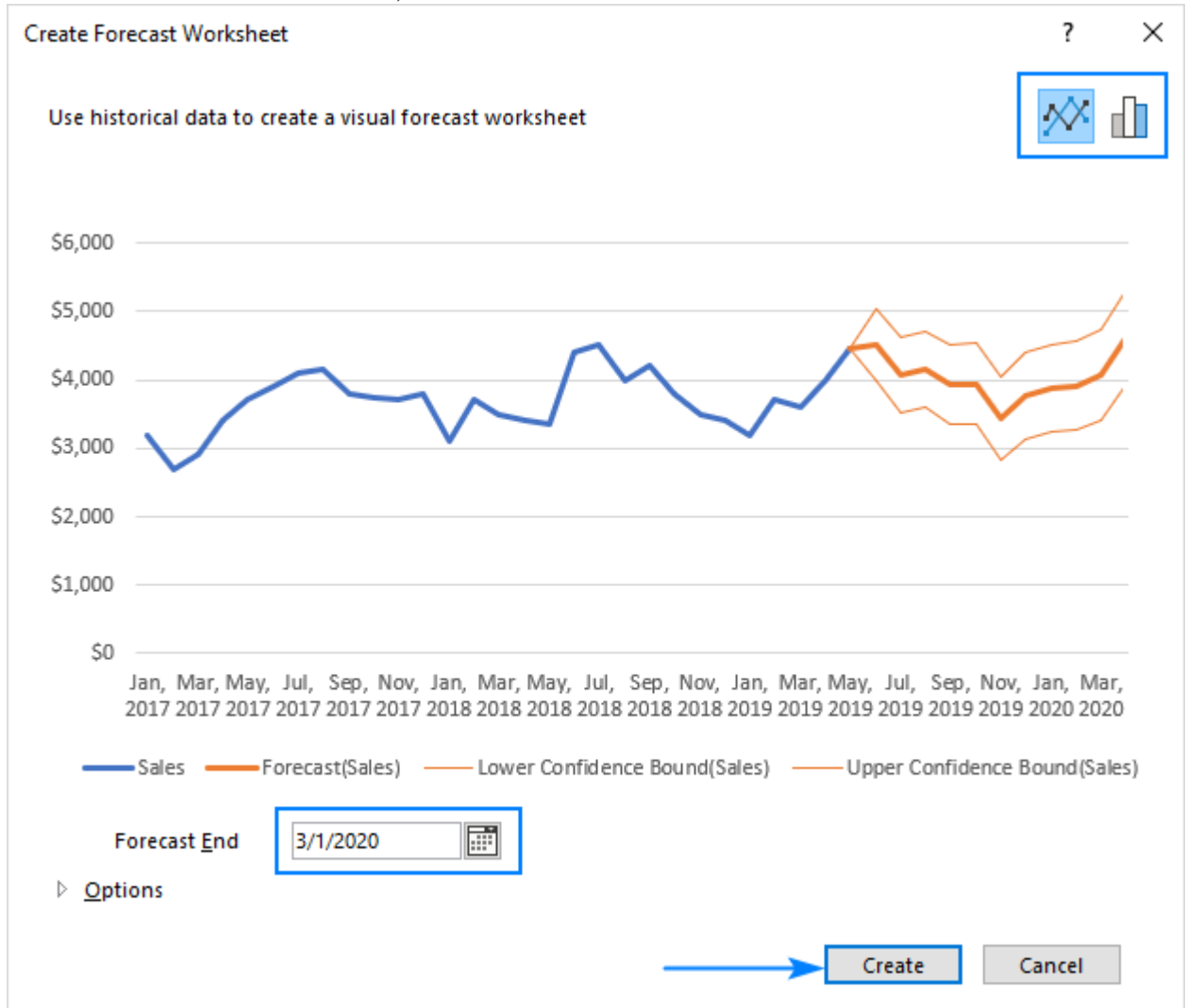
With the two data series in place, carry out the following steps to build a forecasting model:

1. Select both data series. In most cases, it is sufficient to select just one cell in any of your series, and Excel picks up the rest of the data automatically.
2. Go to the *Data* tab > *Forecast* group and click the **Forecast Sheet** button.



3. The *Create Forecast Worksheet* window shows a forecast preview and asks you to choose:
 - Graph type: line (default) or column chart
 - End date for forecasting

4. When done, click the **Create** button.



Excel immediately creates a new sheet containing a table with your original and predicted values as well as a chart that visually represents this data.

The *slope* of the regression line is a measure of the steepness of the line.

It's a numeric value that tells us how two variables are correlated. It tells us how much the dependent variable will change in case there is a change in the independent variable.

There are three ways to find the slope of the regression line for a given set of variables in Excel:

- Using the SLOPE Function
- Using an Excel Scatter chart

In this tutorial, I show you how to calculate slope using each of the above three methods.

This Tutorial Covers:



- [What is Slope? An Overview](#)
- [Method 1: Using the Excel SLOPE Function](#)
 - [SLOPE Function Syntax in Excel](#)
 - [Points to Remember when Using the SLOPE Function in Excel](#)
- [Method 2 – Using a Scatter Chart to get the Slope Value](#)

What is Slope? An Overview

A Slope is a value that tells us how two values (usually called the x and y values) are related to each other.

To give you a simple example, if you have the data about the height and yearly income of some people and you calculate the slope for this data, it will tell you whether there is a positive or negative correlation between these data points.

	A	B
1	Height (cm)	Income (USD)
2	160	107287
3	186	93996
4	185	96532
5	184	68453
6	187	103477
7	160	101128
8	172	75670
9	184	108729
10	166	64536
11	168	80978
12		
13	Slope	138.56
14		

The slope value can be positive or negative.

In our example, if the slope value is 138, which means that there is a positive correlation between height and the income of people. So if the height increases by 1 centimeter, the income is likely to increase by USD 138.

Apart from the slope, another thing you need to know about is the Intercept.

Let me explain it with the equation:

$$Y = \text{Slope} * X + \text{Intercept}$$

In this equation, we have already calculated the slope, but to truly know what would be the Y value for a given X value, you also need to know the intercept.

Thankfully, Excel has a formula for that as well, and I will cover how to calculate intercept in all the methods.

Method 1: Using the Excel SLOPE Function

The easiest way to calculate slope in Excel is to use the in-built **SLOPE function**.

It finds the slope value of a given set of *x-y* coordinates in one step.

While calculating slope manually could be hard, with the SLOPE function, you just need to give it the *x* and *y* values and it does all the heavy lifting in the backend.

SLOPE Function Syntax in Excel

The syntax for the slope function is:

$$=\text{SLOPE}(y_vals, x_vals)$$

Here, *y_vals* and *x_vals* each consist of an array or range of cells containing numeric dependent data values.

Remember that you need to give the Y values as the first argument and X values as the second argument. If you do it the other way round, you will still get the result but it would be incorrect.

Suppose you have the below dataset as shown below where I have the height (in cm) as X values and average annual income (in USD) as the Y values.

	A	B
1	Height (cm)	Income (USD)
2	160	107287
3	186	93996
4	185	96532
5	184	68453
6	187	103477
7	160	101128
8	172	75670
9	184	108729
10	166	64536
11	168	80978
12		
13	Slope	
14	Intercept	

Below is the formula to calculate slope using this dataset:

=SLOPE(B2:B11,A2:A11)

	A	B	C
1	Height (cm)	Income (USD)	
2	160	107287	
3	186	93996	
4	185	96532	
5	184	68453	
6	187	103477	
7	160	101128	
8	172	75670	
9	184	108729	
10	166	64536	
11	168	80978	
12			
13	Slope	138.56	
14	Intercept		

```
=SLOPE(B2:B11,A2:A11)
```

The above result tells me that from this dataset, I can assume that in case the height increases by 1 cm, the income would increase by USD 138.58.

Another common statistical value that people often calculate when working with slope is to calculate the **Intercept value**.

Just to refresh, the slope equation is something as shown below:

$$Y = \text{Slope} * X + \text{Intercept}$$

While we know the slope, we would also need to know the intercept value to make sure we can calculate Y values for any X value.

This can easily be done using the below formula:

=INTERCEPT(B2:B11,A2:A11)

	A	B	C
1	Height (cm)	Income (USD)	
2	160	107287	
3	186	93996	
4	185	96532	
5	184	68453	
6	187	103477	
7	160	101128	
8	172	75670	
9	184	108729	
10	166	64536	
11	168	80978	
12			
13	Slope	138.56	
14	Intercept	65803.16	

With this, our equation for this dataset becomes:

$$Y = 138.56 * X + 65803.2$$

So now, if I ask you what would be the income of anyone whose height is 165 cm, you can calculate the value easily.

$$Y = 138.56 * 165 + 65803.2$$

Both slope and intercept values can be positive or negative

Points to Remember when Using the SLOPE Function in Excel

Here are a few points to remember when finding the slope of a regression line using the SLOPE function:

- Arguments of the SLOPE function have to be numerical (DATE values are also accepted). In case any of the cells are blank or contains a text string, these would be ignored
 - In case there is '0' in any cell/cells, it would be used in the calculation
- There should be an equal number of x and y values, when used as input for the SLOPE function. In case you give it unequal sized ranges, you will get a [#N/A error](#)
- There should be more than one set of points, otherwise the SLOPE function returns a #DIV! error

Method 2 – Using a Scatter Chart to get the Slope Value

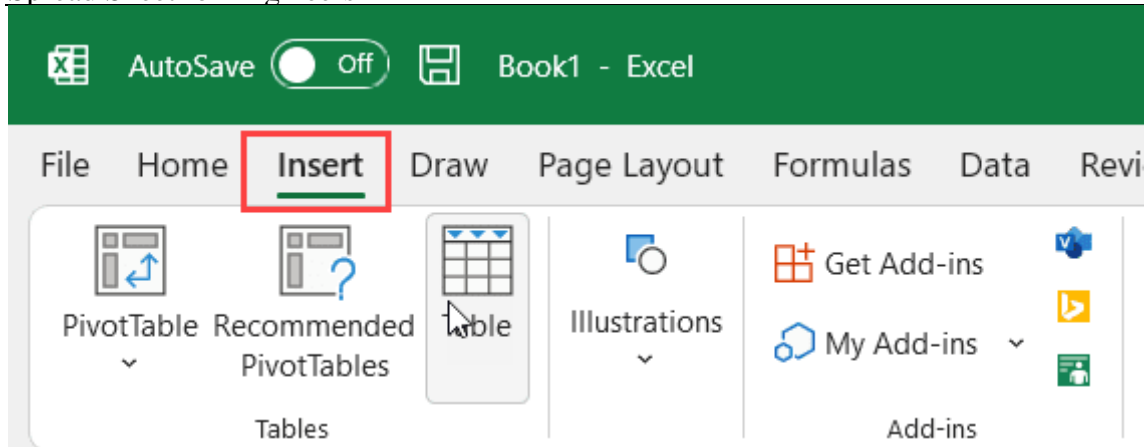
If you prefer to visualize your data and the regression line, you can plot the data in a [scatter chart](#) and use it to find the slope and the intercept for the [trend line \(also called the line of best fit\)](#).

Suppose you have the dataset as shown below and you want to find out the slope and intercept for this data:

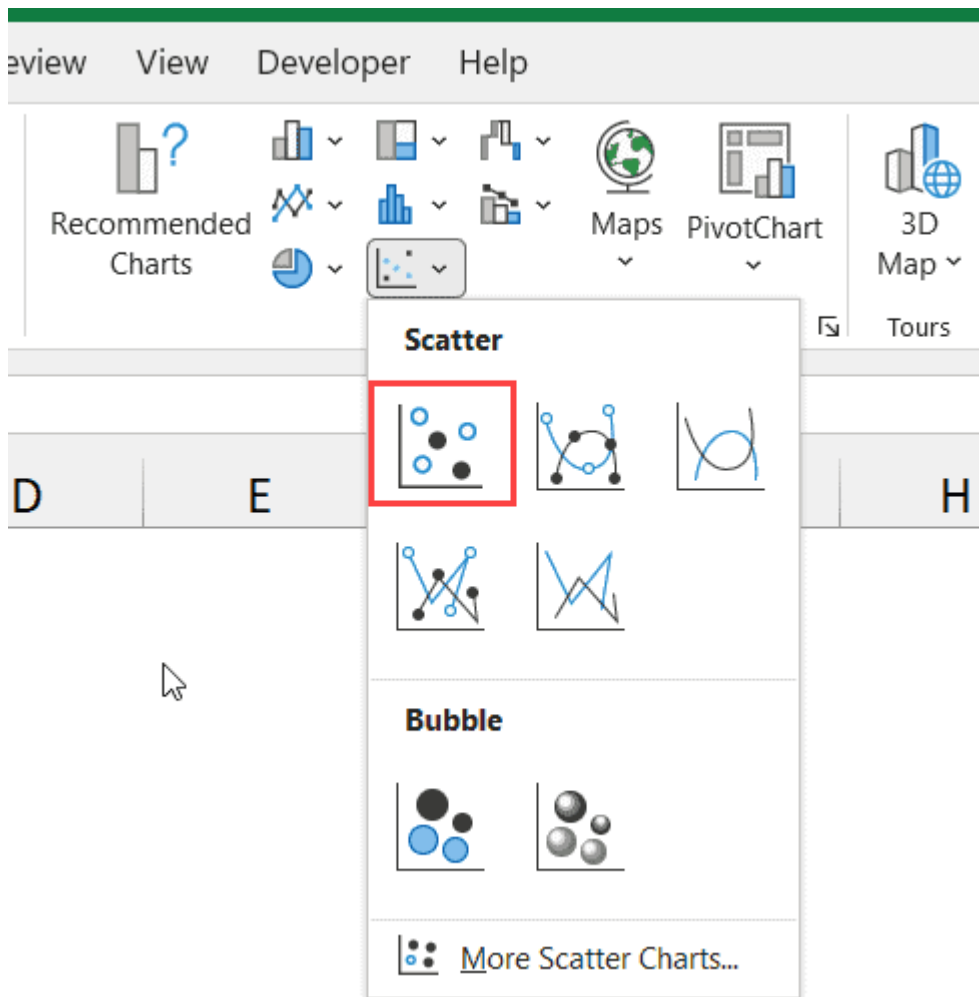
	A	B
1	Height (cm)	Income (USD)
2	160	107287
3	186	93996
4	185	96532
5	184	68453
6	187	103477
7	160	101128
8	172	75670
9	184	108729
10	166	64536
11	168	80978

Below are the steps to do this:

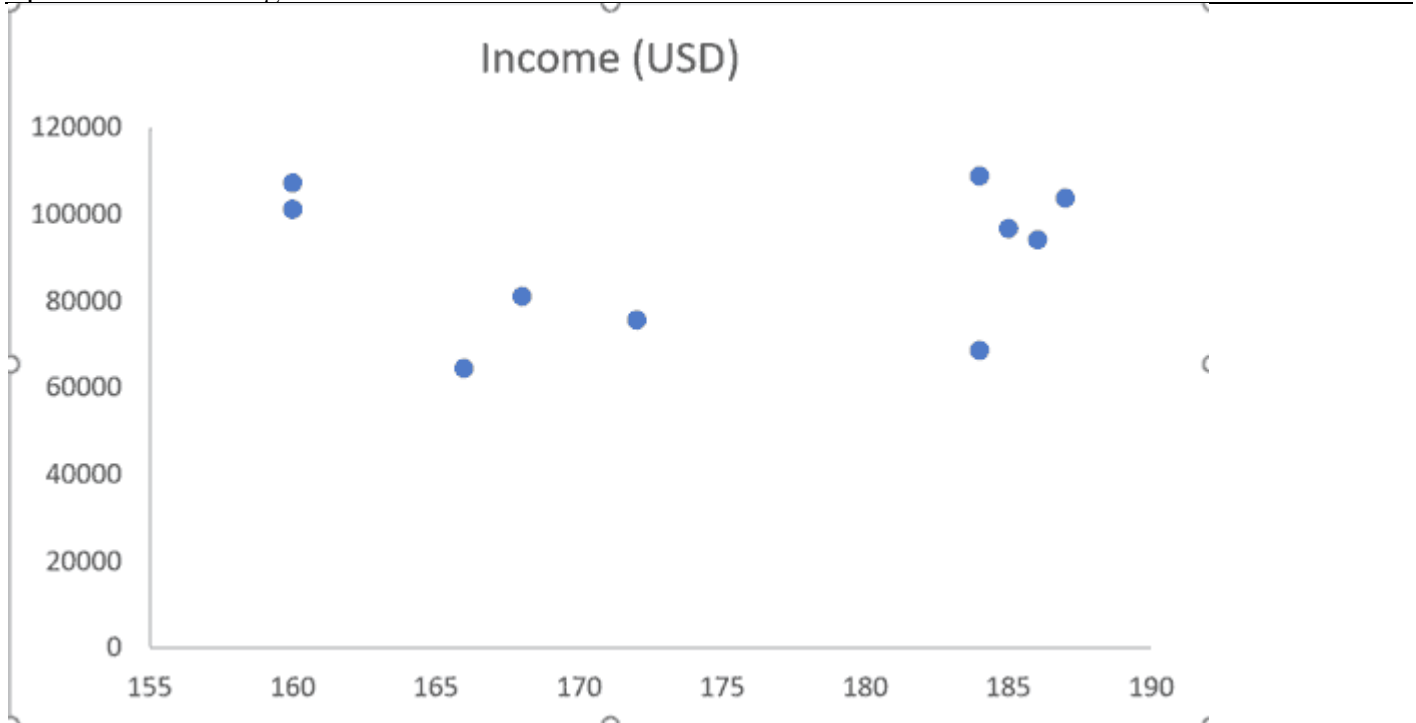
1. Select both X and Y data points (in our example, it would be the height and income column)
2. Click on the 'Insert' tab in the ribbon



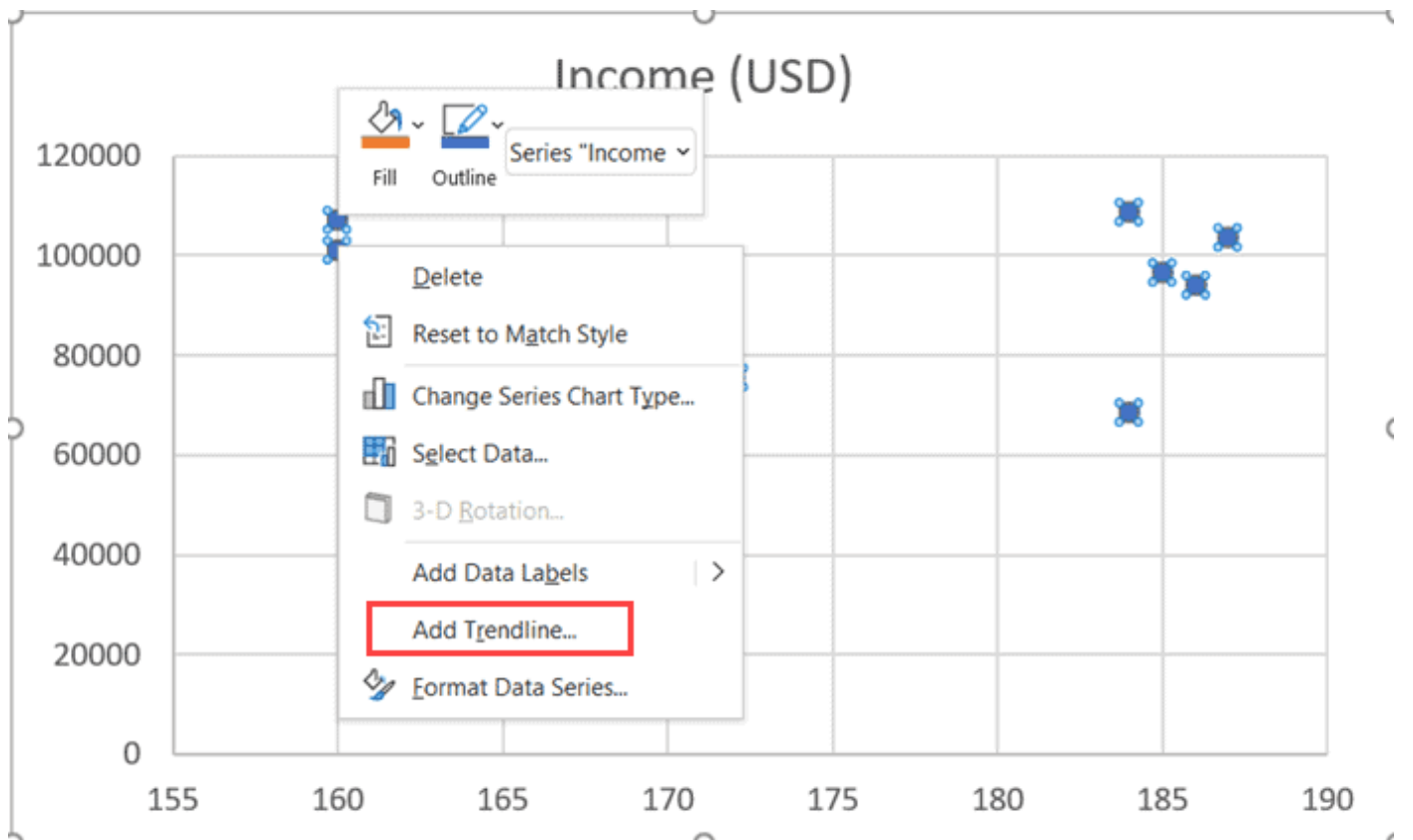
3. Click on the 'Insert scatter' dropdown (under the Charts group)
4. From the dropdown that appears, select the 'Scatter chart' option



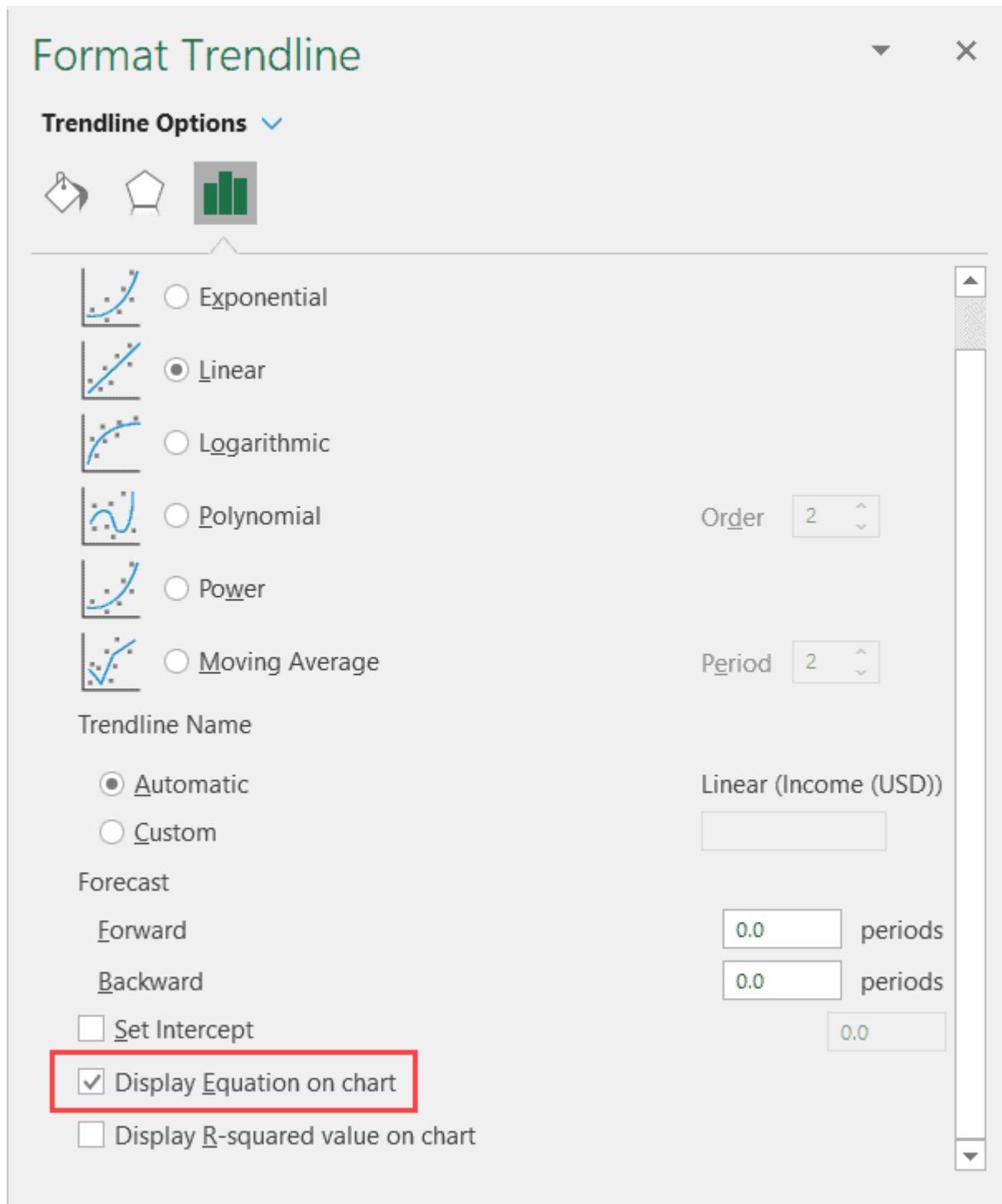
5. This will insert a scatter chart into your worksheet, displaying your x-y values as scatter points (as shown below)



6. Right-click on one of the scatter points, and select 'Add Trendline' from the context menu that appears. This will insert the trendline and also open the 'Format Trendline' pane in the right

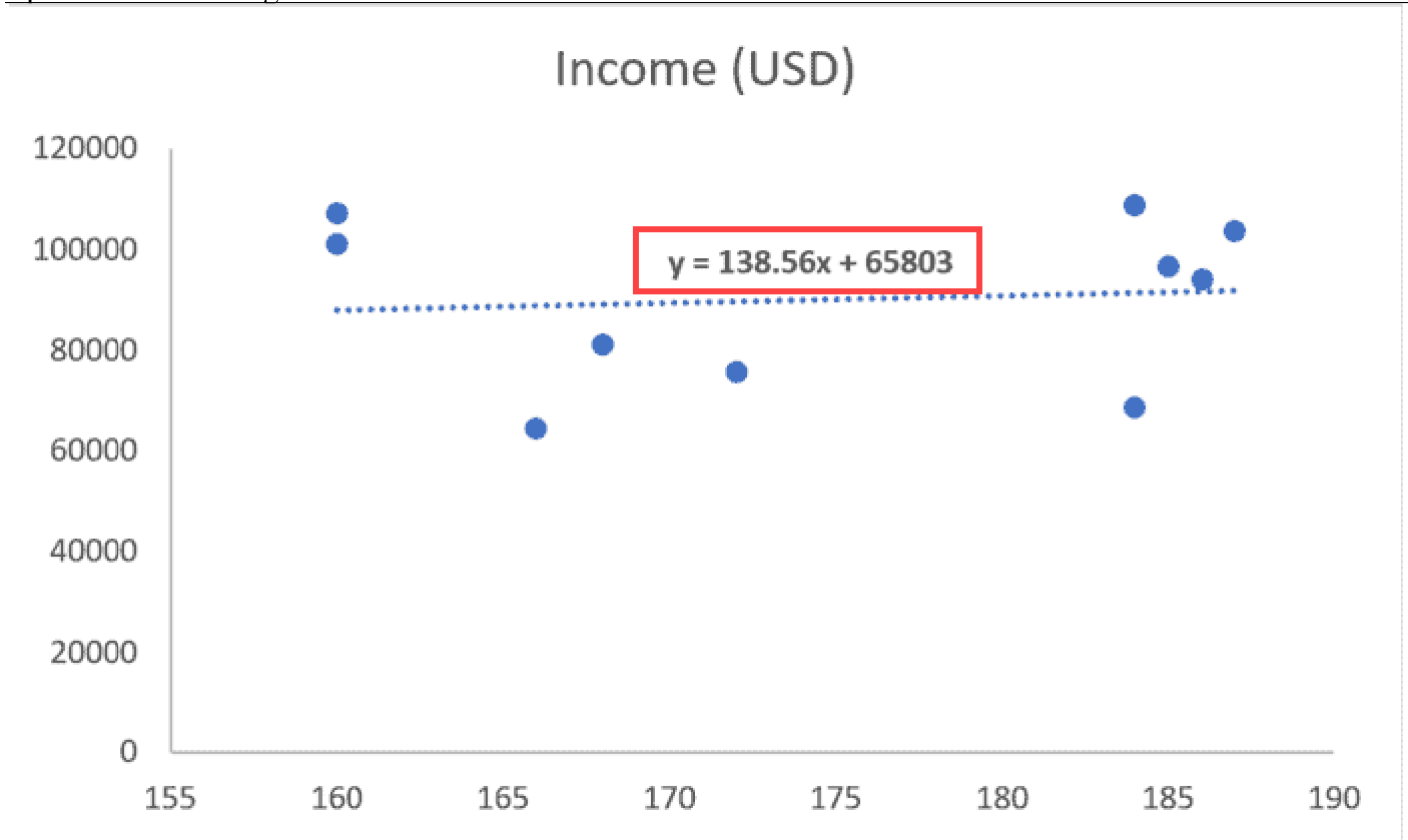


7. In the Format Trendline pane, within the 'Trendline Options', select the 'Display Equation on chart' checkbox



8. Close the Format Trendline pane

The above steps would insert a scatter chart that has a trendline, and the trendline also has the slope and intercept equation.



In our example, we get the below equation:

$$y = 138.56x + 65803$$

Here:

- 138.56 is the slope of the regression line.
- 65803 is the intercept of the regression line.

You can compare this with the values we got from the SLOPE and INTERCEPT functions (it's the same value).

If the slope value is positive, you'll see the trend line going up, and if the slope value is negative, then you will see the trend line going down. The steepness of the slope would be dependent on its slope value

While the formula method to calculate slope and intercept is easy, the benefit of using the scatter chart method is that you can visually see the distribution of the data points as well as the slope of the regression line.

And in case you are anyway creating a scatter chart for your data, getting the slope value by adding a trendline would actually be faster than using the formulas.

So these are two really simple ways that you can use to calculate the slope and the intercept value of a data set in Excel.

Lincet

LINEST function

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This article describes the formula syntax and usage of the **LINEST** function in Microsoft Excel. Find links to more information about charting and performing a regression analysis in the **See Also** section.

Description

The **LINEST** function calculates the statistics for a line by using the "least squares" method to calculate a straight line that best fits your data, and then returns an array that describes the line. You can also combine **LINEST** with other functions to calculate the statistics for other types of models that are linear in the unknown parameters, including polynomial, logarithmic, exponential, and power series. Because this function returns an array of values, it must be entered as an array formula. Instructions follow the examples in this article.

The equation for the line is:

$$y = mx + b$$

–or–

$$y = m_1x_1 + m_2x_2 + \dots + b$$

if there are multiple ranges of x-values, where the dependent y-values are a function of the independent x-values. The m-values are coefficients corresponding to each x-value, and b is a constant value. Note that y, x, and m can be vectors. The array that the **LINEST** function returns is {m_n,m_{n-1},...,m₁,b}. **LINEST** can also return additional regression statistics.

Syntax

LINEST(known_y's, [known_x's], [const], [stats])

The LINEST function syntax has the following arguments:

Syntax

- **known_y's** Required. The set of y-values that you already know in the relationship $y = mx + b$.
 - If the range of *known_y's* is in a single column, each column of *known_x's* is interpreted as a separate variable.
 - If the range of *known_y's* is contained in a single row, each row of *known_x's* is interpreted as a separate variable.
- **known_x's** Optional. A set of x-values that you may already know in the relationship $y = mx + b$.
 - The range of *known_x's* can include one or more sets of variables. If only one variable is used, *known_y's* and *known_x's* can be ranges of any shape, as long as they have equal dimensions. If more than one variable is used, *known_y's* must be a vector (that is, a range with a height of one row or a width of one column).
 - If *known_x's* is omitted, it is assumed to be the array {1,2,3,...} that is the same size as *known_y's*.
- **const** Optional. A logical value specifying whether to force the constant b to equal 0.
 - If *const* is TRUE or omitted, b is calculated normally.
 - If *const* is FALSE, b is set equal to 0 and the m-values are adjusted to fit $y = mx$.
- **stats** Optional. A logical value specifying whether to return additional regression statistics.
 - If *stats* is TRUE, **LINEST** returns the additional regression statistics; as a result, the returned array is {mn,mn-1,...,m1,b;sen,sen-1,...,se1,seb;r²,sey;F,df;ssreg,ssresid}.
 - If *stats* is FALSE or omitted, **LINEST** returns only the m-coefficients and the constant b.

The additional regression statistics are as follows.

Statistic	Description
se1,se2,...,sen	The standard error values for the coefficients m1,m2,...,mn.
seb	The standard error value for the constant b (seb = #N/A when <i>const</i> is FALSE).
r ²	The coefficient of determination. Compares estimated and actual y-values, and ranges in value from 0 to 1. If it is 1, there is a perfect correlation in the sample — there is no difference between the estimated y-value and the actual y-value. At the other extreme, if the coefficient of determination is 0, the regression equation is not helpful in predicting a y-value. For information about how r ² is calculated, see "Remarks," later in this topic.
sey	The standard error for the y estimate.
F	The F statistic, or the F-observed value. Use the F statistic to determine whether the observed relationship between the dependent and independent variables occurs by chance.
df	The degrees of freedom. Use the degrees of freedom to help you find F-critical values in a statistical table. Compare the values you find in the table to the F statistic returned by LINEST to determine a confidence level for the model. For information about how

Statistic	Description
ssreg	df is calculated, see "Remarks," later in this topic. Example 4 shows use of F and df. The regression sum of squares.
ssresid	The residual sum of squares. For information about how ssreg and ssresid are calculated, see "Remarks," later in this topic.

The following illustration shows the order in which the additional regression statistics are returned.

	A	B	C	D	E	F
1	m_n	m_{n-1}	...	m_2	m_1	b
2	se_n	se_{n-1}	...	se_2	se_1	se_b
3	r^2	se_y				
4	F	df				
5	ssreg	ssresid				

Remarks

- You can describe any straight line with the slope and the y-intercept:

Slope (m):
To find the slope of a line, often written as m, take two points on the line, (x1,y1) and (x2,y2); the slope is equal to $(y_2 - y_1)/(x_2 - x_1)$.

Y-intercept (b):
The y-intercept of a line, often written as b, is the value of y at the point where the line crosses the y-axis.

The equation of a straight line is $y = mx + b$. Once you know the values of m and b, you can calculate any point on the line by plugging the y- or x-value into that equation. You can also use the **TREND** function.

- When you have only one independent x-variable, you can obtain the slope and y-intercept values directly by using the following formulas:

Slope:
=INDEX(LINEST(known_y's,known_x's),1)

Y-intercept:
=INDEX(LINEST(known_y's,known_x's),2)

- The accuracy of the line calculated by the **LINEST** function depends on the degree of scatter in your data. The more linear the data, the more accurate the **LINEST** model. **LINEST** uses the method of least squares for determining the best fit for the data. When you have only one independent x-variable, the calculations for m and b are based on the following formulas:

$$m = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$$

$$b = \bar{y} - m\bar{x}$$

where \bar{x} and \bar{y} are sample means; that is, $\bar{x} = \text{AVERAGE}(\text{known_x's})$ and $\bar{y} = \text{AVERAGE}(\text{known_y's})$.

- The line- and curve-fitting functions **LINEST** and **LOGEST** can calculate the best straight line or exponential curve that fits your data. However, you have to decide which of the two results best fits your data. You can calculate **TREND(known_y's, known_x's)** for a straight line, or **GROWTH(known_y's, known_x's)** for an exponential curve. These functions, without the *new_x's* argument, return an array of y-values predicted along that line or curve at your actual data points. You can then compare the predicted values with the actual values. You may want to chart them both for a visual comparison.
- In regression analysis, Excel calculates for each point the squared difference between the y-value estimated for that point and its actual y-value. The sum of these squared differences is called the residual sum of squares, *ssresid*. Excel then calculates the total sum of squares, *sstotal*. When the *const* argument = TRUE or is omitted, the total sum of squares is the sum of the squared differences between the actual y-values and the average of the y-values. When the *const* argument = FALSE, the total sum of squares is the sum of the squares of the actual y-values (without subtracting the average y-value from each individual y-value). Then regression sum of squares, *ssreg*, can be found from: $ssreg = sstotal - ssresid$. The smaller the residual sum of squares is, compared with the total sum of squares, the larger the value of the coefficient of determination, r^2 , which is an indicator of how well the equation resulting from the regression analysis explains the relationship among the variables. The value of r^2 equals $ssreg/sstotal$.
- In some cases, one or more of the X columns (assume that Y's and X's are in columns) may have no additional predictive value in the presence of the other X columns. In other words, eliminating one or more X columns might lead to predicted Y values that are equally accurate. In that case these redundant X columns should be omitted from the regression model. This phenomenon is called "collinearity" because any redundant X column can be expressed as a sum of multiples of the non-redundant X columns. The **LINEST** function checks for collinearity and removes any redundant X columns from the regression model when it identifies them. Removed X columns can be recognized in **LINEST** output as having 0 coefficients in addition to 0 se values. If one or more columns are removed as redundant, *df* is affected because *df* depends on the number of X columns actually used for predictive purposes. For details on the computation of *df*, see [Example 4](#). If *df* is changed because redundant X columns are removed, values of *sey* and *F* are also affected. Collinearity should be relatively rare in practice. However, one case where it is more likely to arise is when some X columns contain only 0 and 1 values as indicators of whether a subject in an experiment is or is not a member of a particular group. If *const* = TRUE or is omitted, the **LINEST** function effectively inserts an additional X column of all 1 values to model the intercept. If you have a column with a 1 for each subject if male, or 0 if not, and you also have a column with a 1 for each subject if female, or 0 if not, this latter column is redundant because entries in it can be obtained from subtracting the entry in the "male indicator" column from the entry in the additional column of all 1 values added by the **LINEST** function.

- The value of df is calculated as follows, when no X columns are removed from the model due to collinearity: if there are k columns of *known_x's* and *const* = TRUE or is omitted, $df = n - k - 1$. If *const* = FALSE, $df = n - k$. In both cases, each X column that was removed due to collinearity increases the value of df by 1.
- When entering an array constant (such as *known_x's*) as an argument, use commas to separate values that are contained in the same row and semicolons to separate rows. Separator characters may be different depending on your regional settings.
- Note that the y-values predicted by the regression equation may not be valid if they are outside the range of the y-values you used to determine the equation.
- The underlying algorithm used in the **LINEST** function is different than the underlying algorithm used in the **SLOPE** and **INTERCEPT** functions. The difference between these algorithms can lead to different results when data is undetermined and collinear. For example, if the data points of the *known_y's* argument are 0 and the data points of the *known_x's* argument are 1:
 - **LINEST** returns a value of 0. The algorithm of the **LINEST** function is designed to return reasonable results for collinear data and, in this case, at least one answer can be found.
 - **SLOPE** and **INTERCEPT** return a #DIV/0! error. The algorithm of the **SLOPE** and **INTERCEPT** functions is designed to look for only one answer, and in this case there can be more than one answer.
- In addition to using **LOGEST** to calculate statistics for other regression types, you can use **LINEST** to calculate a range of other regression types by entering functions of the x and y variables as the x and y series for **LINEST**. For example, the following formula:

=LINEST(yvalues, xvalues^COLUMN(\$A:\$C))

works when you have a single column of y-values and a single column of x-values to calculate the cubic (polynomial of order 3) approximation of the form:

$$y = m1*x + m2*x^2 + m3*x^3 + b$$

You can adjust this formula to calculate other types of regression, but in some cases it requires the adjustment of the output values and other statistics.

- The F-test value that is returned by the LINEST function differs from the F-test value that is returned by the [FTEST function](#). LINEST returns the F statistic, whereas FTEST returns the probability.

Example 1 - Slope and Y-Intercept

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Known y	Known x
1	0
9	4
5	2
7	3
Result (slope)	Result (y-intercept)
2	1
Formula (array formula in cells A7:B7)	
=LINEST(A2:A5,B2:B5,,FALSE)	

Example 2 - Simple Linear Regression

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Month	Sales
1	\$3,100
2	\$4,500
3	\$4,400
4	\$5,400
5	\$7,500
6	\$8,100
Formula	Result
=SUM(LINEST(B1:B6, A1:A6)*{9,1})	\$11,000
	Calculates the estimate of the sales in the ninth month, based on sales in months 1 through 6.

Example 3 - Multiple Linear Regression

Copy the example data in the following table, and paste it in cell A1 of a new Excel worksheet. For formulas to show results, select them, press F2, and then press Enter. If you need to, you can adjust the column widths to see all the data.

Floor space (x1)	Offices (x2)	Entrances (x3)	Age (x4)	Assessed value (y)
------------------	--------------	----------------	----------	--------------------

Floor space (x1)	Offices (x2)	Entrances (x3)	Age (x4)	Assessed value (y)
2310	2	2	20	\$142,000
2333	2	2	12	\$144,000
2356	3	1.5	33	\$151,000
2379	3	2	43	\$150,000
2402	2	3	53	\$139,000
2425	4	2	23	\$169,000
2448	2	1.5	99	\$126,000
2471	2	2	34	\$142,900
2494	3	3	23	\$163,000
2517	4	4	55	\$169,000
2540	2	3	22	\$149,000
-234.2371645				
13.26801148				
0.996747993				
459.7536742				
1732393319				
Formula (dynamic array formula entered in A19)				
=LINEST(E2:E12,A2:D12,TRUE,TRUE)				

How to Fit a Polynomial Curve in Excel (Step-by-Step)

You can use the **LINEST()** function in Excel to fit a polynomial curve with a certain degree.

For example, you can use the following basic syntax to fit a polynomial curve with a degree of 3:

=LINEST(known_ys, known_xs^{1, 2, 3})

The function returns an array of coefficients that describes the polynomial fit.

The following step-by-step example shows how to use this function to fit a polynomial curve in Excel.

Step 1: Create the Data

First, let's create some data to work with:

	A	B	C	D	E	F	G	H
1	x	y						
2	2	30						
3	3	34						
4	4	30						
5	5	22						
6	6	18						
7	1	24						
8	7	19						
9	8	20						
10	9	22						
11	10	25						
12	11	28						
13	12	31						
14	13	32						
15	14	37						
16	15	43						
17								
18								
19								
20								
21								
22								
23								
24								
25								

Step 2: Fit a Polynomial Curve

Next, let's use the **LINEST()** function to fit a polynomial curve with a degree of 3 to the dataset:

Spread Sheet for Engineers

	A	B	C	D	E	F	G	H
1	x	y						
2	2	30		=LINEST(B2:B16, A2:A16^{1,2,3})				
3	3	34						
4	4	30						
5	5	22						
6	6	18						
7	1	24						
8	7	19						
9	8	20						
10	9	22						
11	10	25						
12	11	28						
13	12	31						
14	13	32						
15	14	37						
16	15	43						
17								
18								
19								
20								
21								
22								
23								
24								
25								

Step 3: Interpret the Polynomial Curve

Once we press **ENTER**, an array of coefficients will appear:

	A	B	C	D	E	F	G	H
1	x	y						
2	2	30		0.021828	-0.22395	-0.60841	30.09158	
3	3	34						
4	4	30						
5	5	22						
6	6	18						
7	1	24						
8	7	19						
9	8	20						
10	9	22						
11	10	25						
12	11	28						
13	12	31						
14	13	32						
15	14	37						
16	15	43						
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

Using these coefficients, we can construct the following equation to describe the relationship between x and y:

$$y = .0218x^3 - .2239x^2 - .6084x + 30.0915$$

We can also use this equation to calculate the expected value of y, based on the value of x.

For example, suppose x = 4. The expected value of y would be:

$$y = .0218(4)^3 - .2239(4)^2 - .6084(4) + 30.0915 = \mathbf{25.47}$$

How to Create a Residual Plot in Excel

A **residual plot** is a type of plot that displays the fitted values against the residual values for a regression model.

This type of plot is often used to assess whether or not a linear regression model is appropriate for a given dataset and to check for heteroscedasticity of residuals.

This tutorial explains how to create a residual plot for a simple linear regression model in Excel.

How to Create a Residual Plot in Excel

Use the following steps to create a residual plot in Excel:

Step 1: Enter the data values in the first two columns. For example, enter the values for the predictor variable in A2:A13 and the values for the response variable in B2:B13.

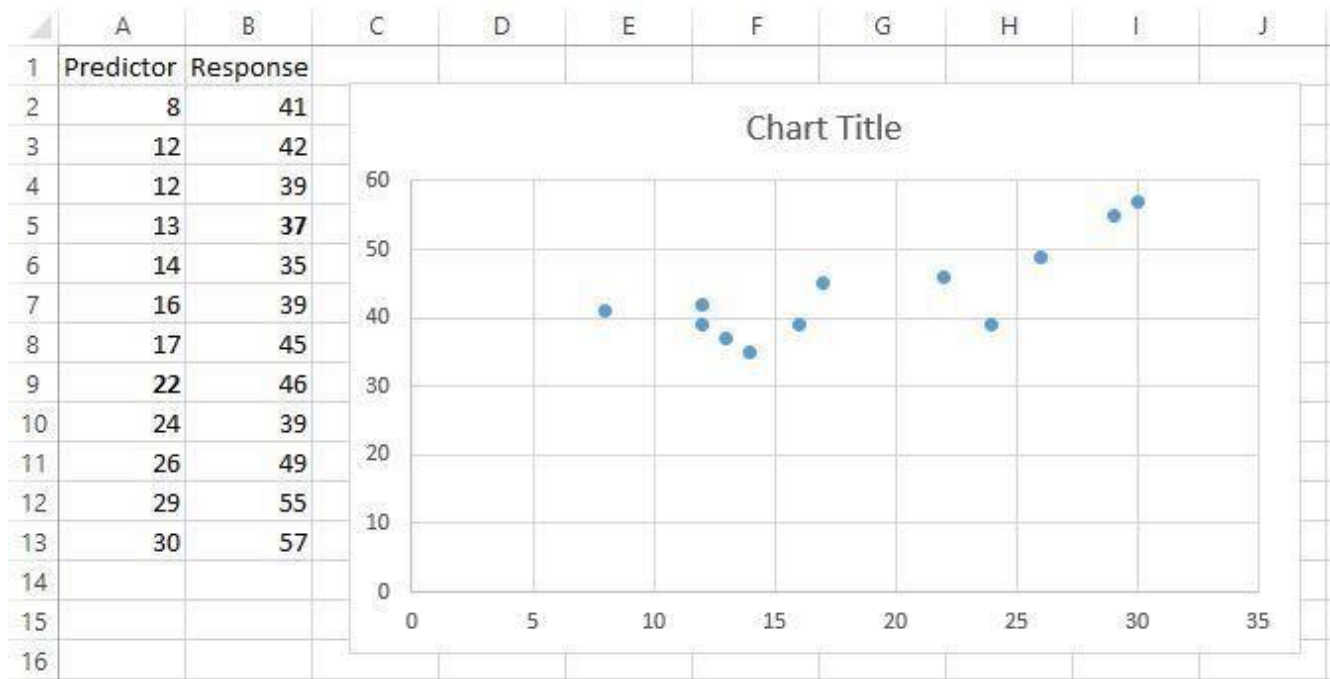
	A	B	C	D	E
1	Predictor	Response			
2	8	41			
3	12	42			
4	12	39			
5	13	37			
6	14	35			
7	16	39			
8	17	45			
9	22	46			
10	24	39			
11	26	49			
12	29	55			
13	30	57			
14					

Step 2: Create a scatterplot. Highlight the values in cells A2:B13. Then, navigate to the *INSERT* tab along the top ribbon. Click on the first option for *Scatter* within the *Charts* area.

Spread Sheet for Engineers

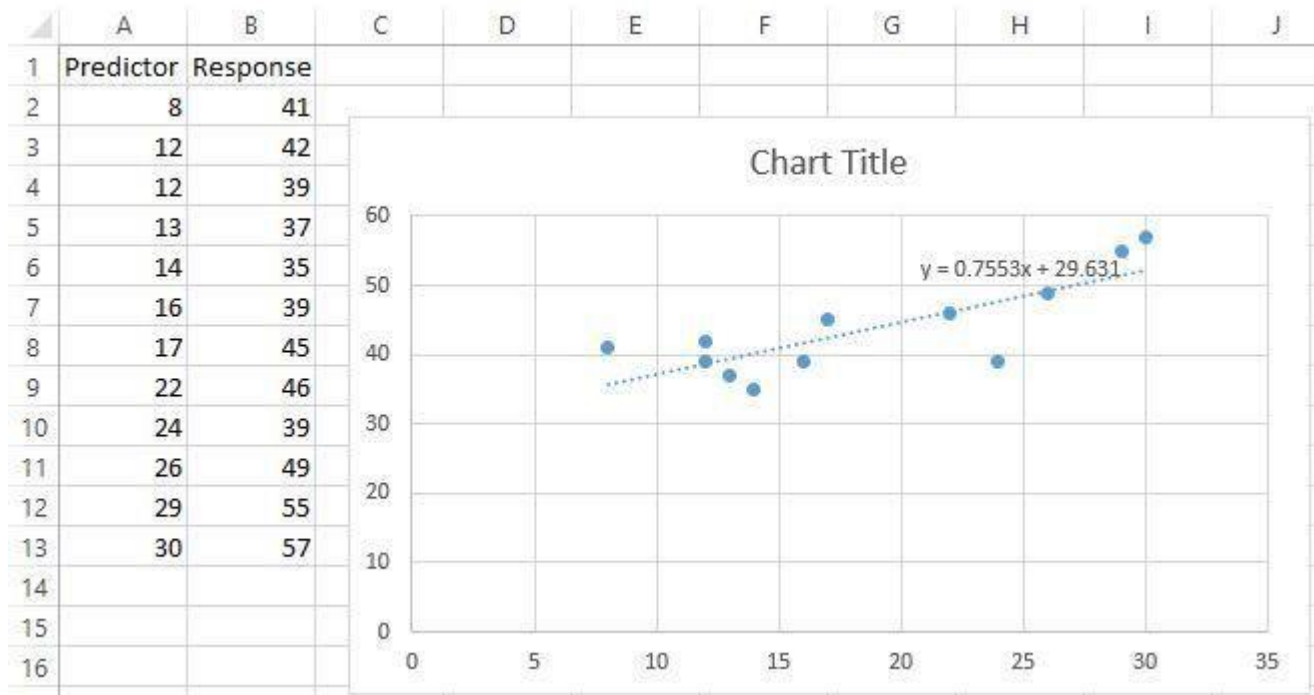
	A	B	C	D	E	F	G	H	I
1	Predictor	Response							
2	8	41							
3	12	42							
4	12	39							
5	13	37							
6	14	35							
7	16	39							
8	17	45							
9	22	46							
10	24	39							
11	26	49							
12	29	55							
13	30	57							

The following chart will appear:



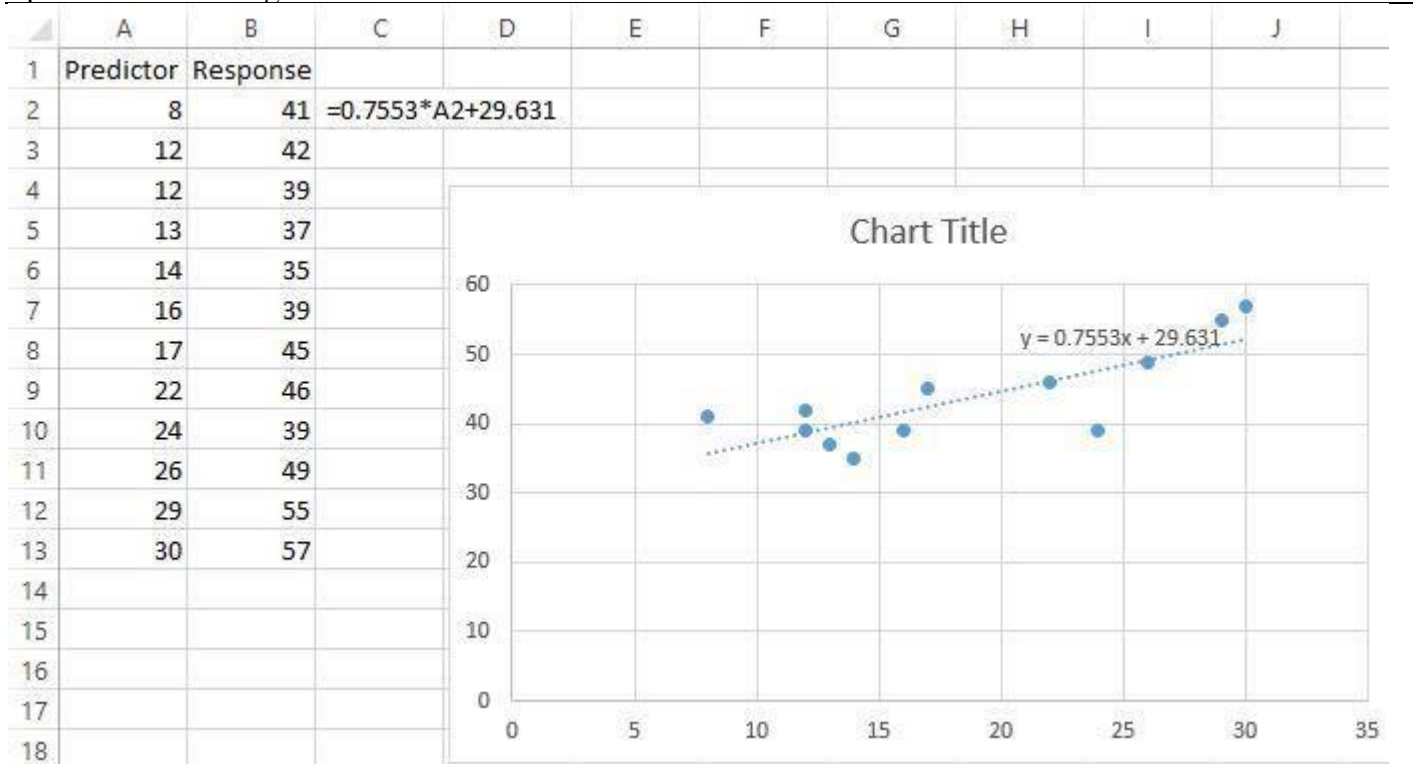
Step 3: Display trend line equation on the scatterplot. Click “Add Chart Elements” from the *DESIGN* tab, then “Trendline”, and then “More Trendline Option. Leave “Linear” selected and check “Display Equation on Chart.” Close the “Format Trendline” panel.

The trend line equation will now be displayed on the scatterplot:

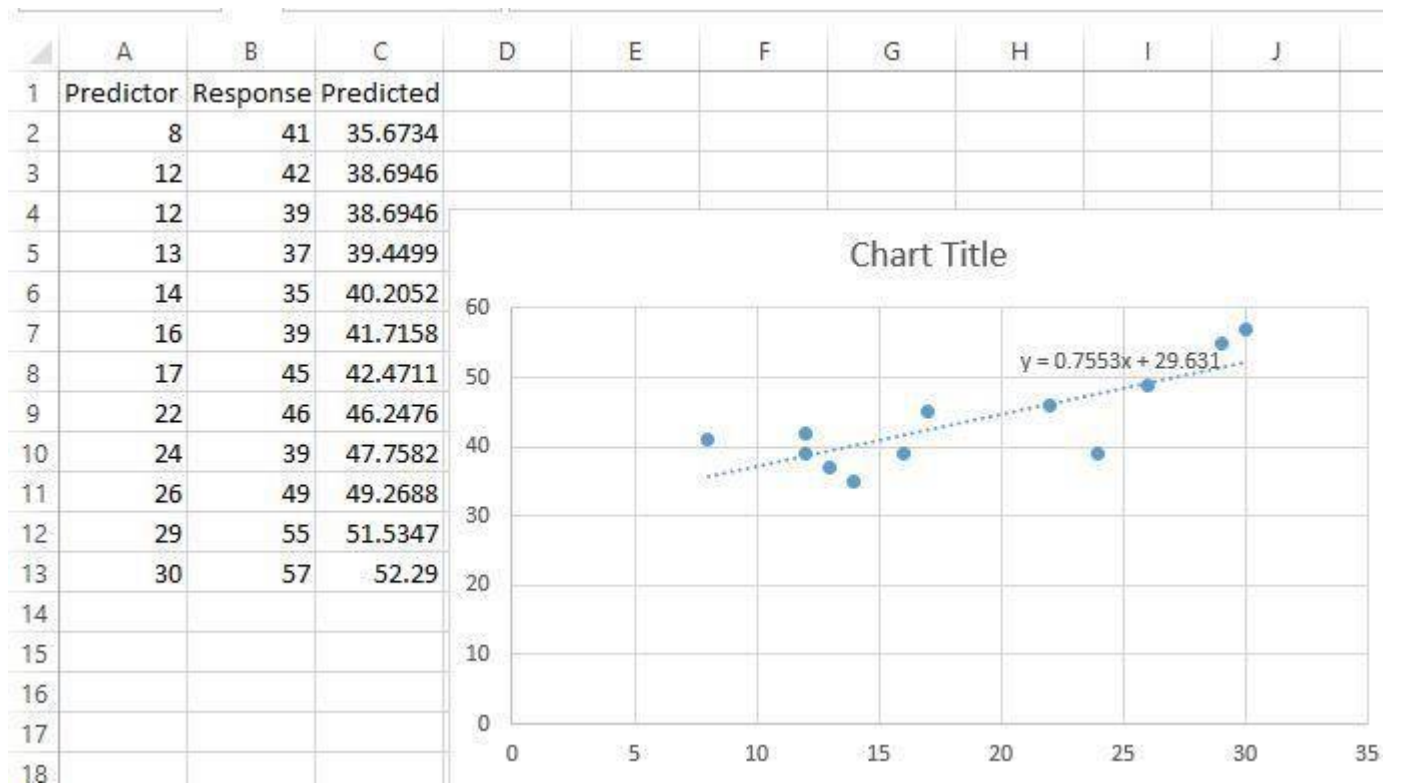


Step 4: Calculate the predicted values. Enter the trendline equation in cell C2, replacing “x” with “A1” like so:

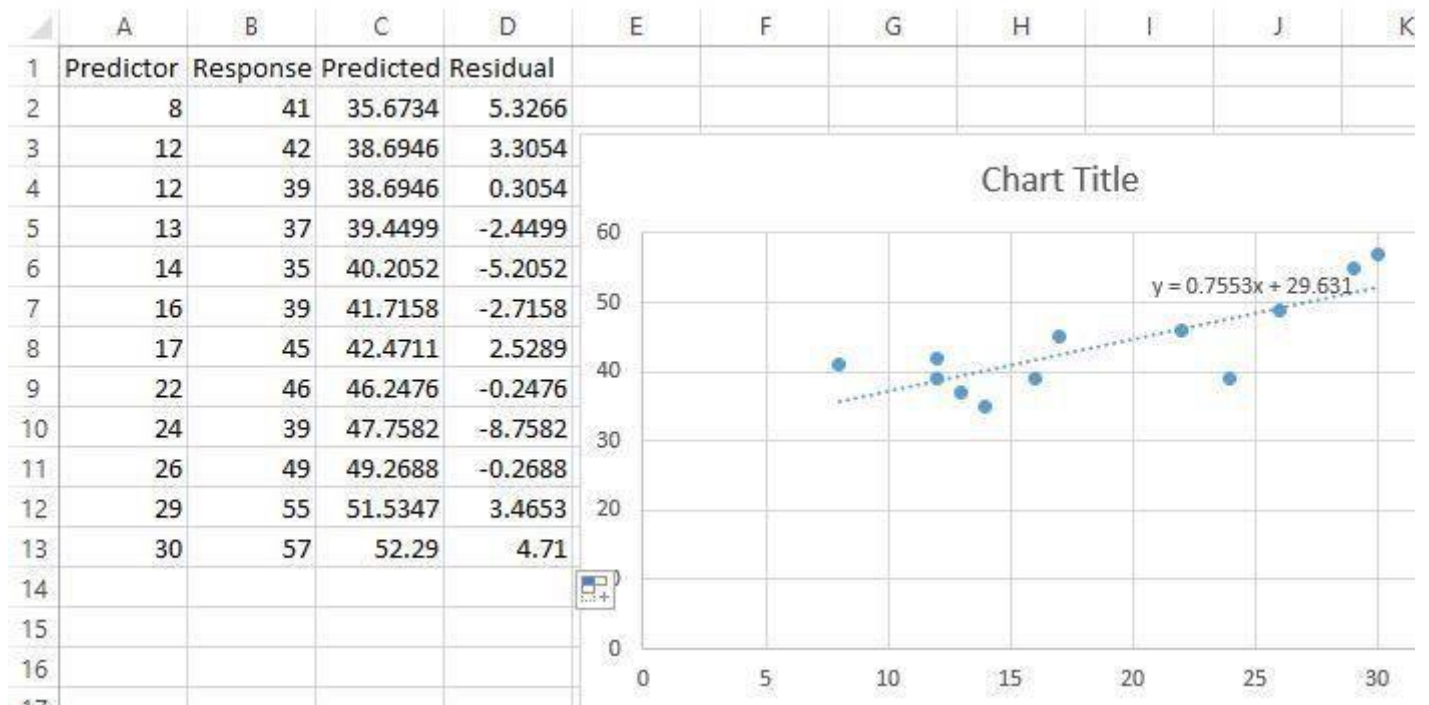
Spread Sheet for Engineers



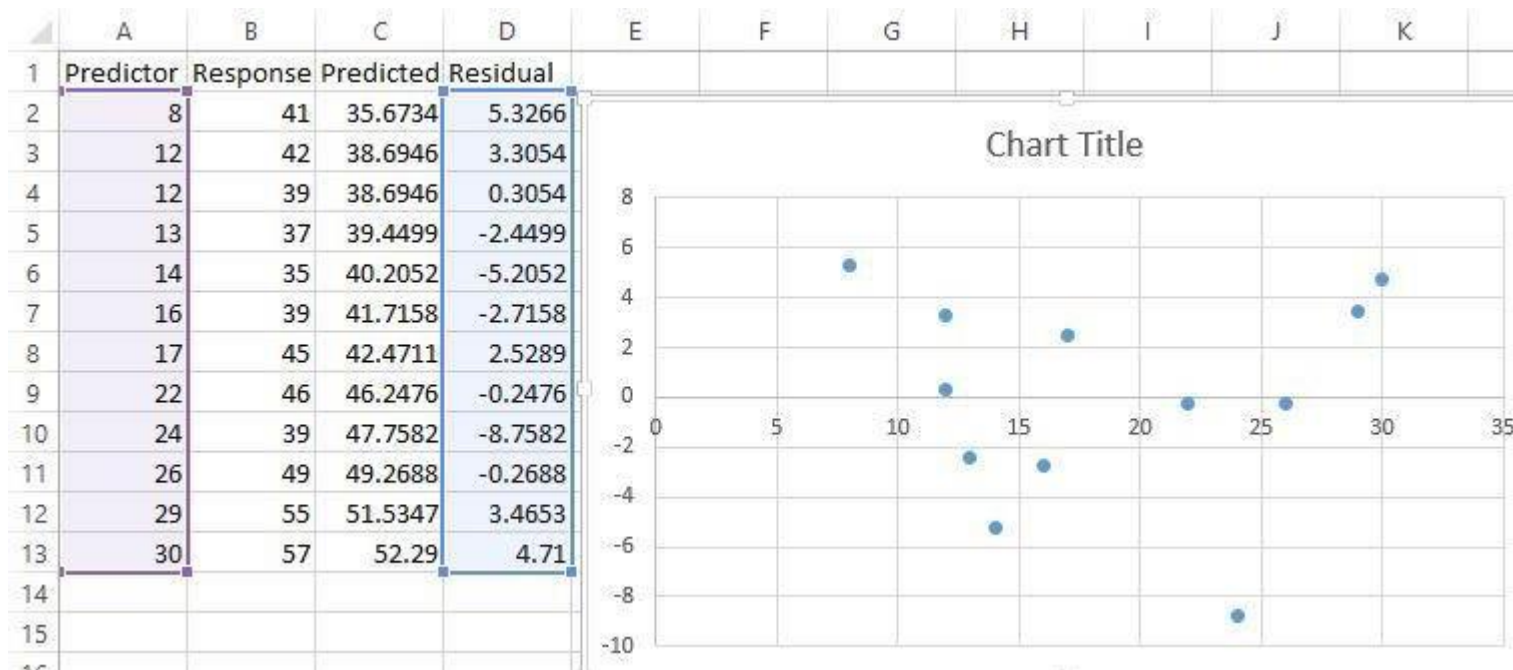
Then, click cell C2 and double-click the small “Fill Handle” at the bottom right of the cell. This will copy the formula in cell C2 to the rest of the cells in the column:



Step 5: Calculate the residuals. Enter $B2-C2$ in cell D2. Then, click cell D2 and double-click the small “Fill Handle” at the bottom right of the cell. This will copy the formula in cell D2 to the rest of the cells in the column:

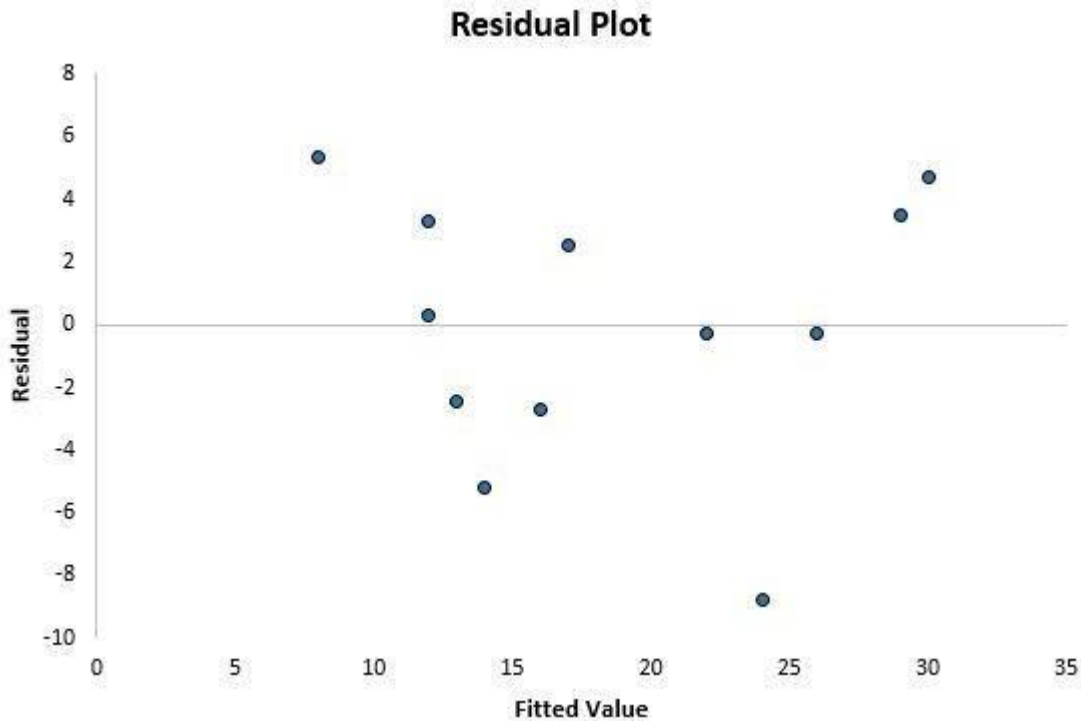


Step 6: Create the residual plot. Highlight cells A2:A13. Hold the “Ctrl” key and highlight cells D2:D13. Then, navigate to the *INSERT* tab along the top ribbon. Click on the first option for *Scatter* within the *Charts* area. The following chart will appear:



This is the residual plot. The x-axis displays the fitted values and the y-axis displays the residuals.

Feel free to modify the title, axes, and gridlines to make the plot look more visually appealing:



Suitable Ways to Find Slope of Tangent Line in Excel

In this article, you will see **two** easy methods to find the slope of a tangent line in **Excel**. The first method will discuss the use of **the SLOPE function** of Excel. In the second method, I will insert the available data into an Excel chart and then find the slope from the equation.

To illustrate my article further, I will use the following sample data set.

	A	B	C
1			
2		Sample Data Set	
3			
4		Equation	Y = X^2+1
5			
6		X Value	Y Value
7		1	
8		2	
9		3	
10		4	
11		5	

1. Apply SLOPE Function to Find Slope of Tangent Line

In the first method, I will apply **the SLOPE function** of Excel for determining the slope of a tangent line. By using the function, you can calculate the slope in Excel. The function will take the **y-axis** and **x-axis** values of an equation as the inputs and then show the slope as a numerical value. Go through the following steps for a better understanding.

Steps:

- First of all, I will assume some values for the **X** variable of the equation in cell **C4**.
- Then, to calculate the values of the **Y** variable, insert the following formula in cell **C7**.

=B7^2+1

Application of SLOPE Function	
Equation	$Y = X^2+1$
X Value	Y Value
1	=B7^2+1
2	
3	
4	
5	

- Secondly, press **Enter** and use **AutoFill** to get the desired result for the lower cells as well.

Application of SLOPE Function	
Equation	$Y = X^2+1$
X Value	Y Value
1	2
2	5
3	10
4	17
5	26

- Thirdly, to find the slope, make an extra field in cell **C13** and type the following formula.

$$=SLOPE(C7:C11,B7:B11)$$

The screenshot shows an Excel spreadsheet with the following content:

- Row 2: **Application of SLOPE Function**
- Row 4: **Equation** | $Y = X^2 + 1$
- Row 6: **X Value** | **Y Value**
- Row 7: 1 | 2
- Row 8: 2 | 5
- Row 9: 3 | 10
- Row 10: 4 | 17
- Row 11: 5 | 26
- Row 13: **Slope** | `=SLOPE(C7:C11,B7:B11)`

The formula bar at the top shows `=SLOPE(C7:C11,B7:B11)` and the formula in cell C13 is also `=SLOPE(C7:C11,B7:B11)`.

- Finally, press **Enter** to get the slope that is 6.

The screenshot shows the same Excel spreadsheet as above, but with the result of the SLOPE function displayed in cell C13:

- Row 13: **Slope** | 6

The formula bar at the top still shows `=SLOPE(C7:C11,B7:B11)`.

2. Insert Data into Excel Chart to Find Slope of Tangent Line

In the second method, instead of using any function, I will insert the available data set for making an **Excel** chart. After making the chart, I will find the [slope from the trendline](#). Let's follow the instruction below to find the slope of the tangent line!

Steps:

- Firstly, calculate the values of the **y-axis** for the equation of cell **C4** just like the previous method.
- Then, select the data range **B6:C11** and go to the **Insert** tab of the ribbon.
- Afterward, from the **Charts** group, select **Insert Scatter (X,Y) or Bubble Chart**.

The screenshot shows the Excel interface with the 'Insert' tab selected. In the 'Charts' group, the 'Scatter' icon is highlighted with a red box and a red circle containing the number '3'. The formula bar shows 'X Value' in cell B6. The worksheet contains the following data:

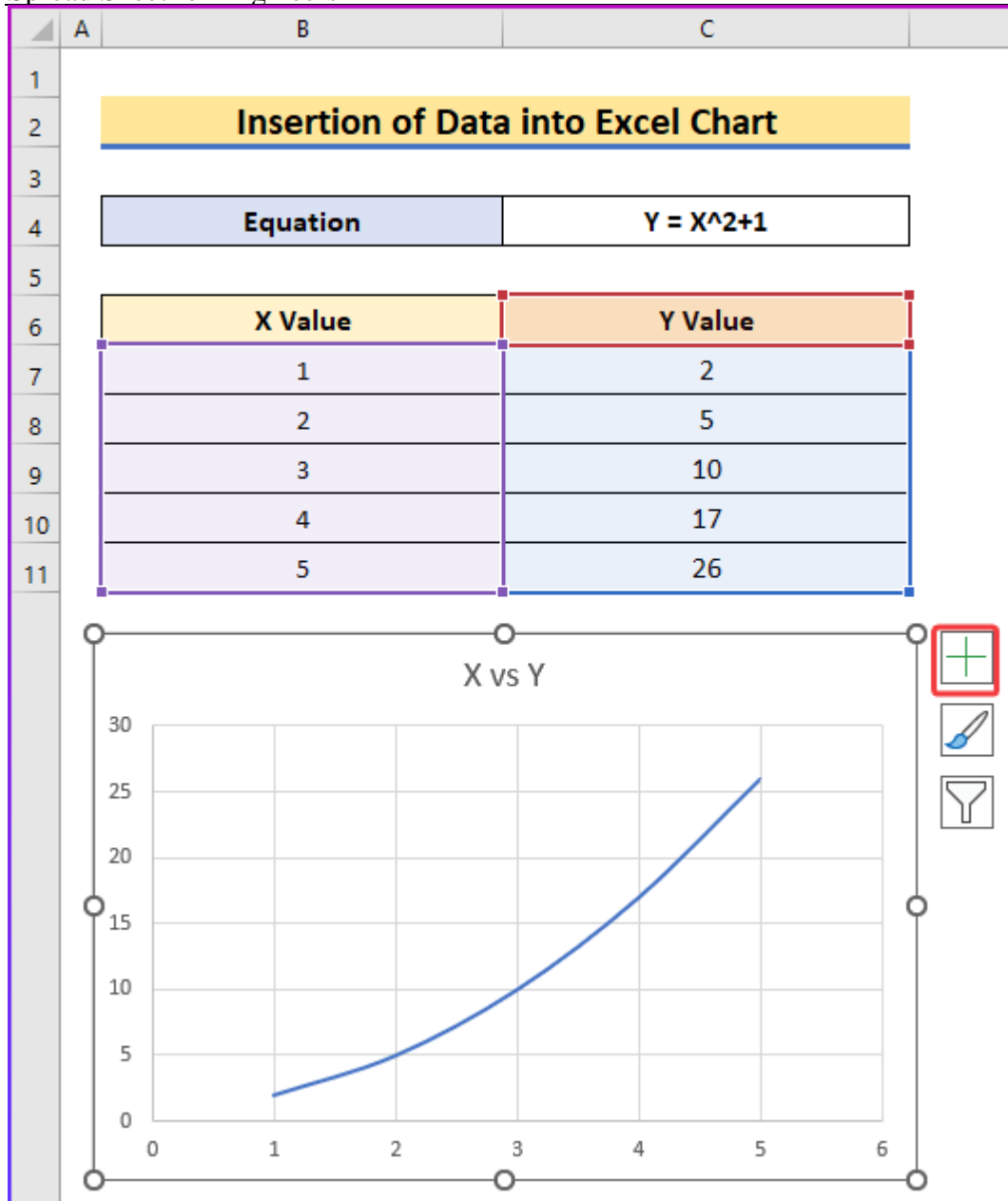
Insertion of Data into Excel Chart	
Equation	$Y = X^2 + 1$
X Value	Y Value
1	2
2	5
3	10
4	17
5	26

- Secondly, from the dropdown, choose **Scatter with Smooth Lines**.

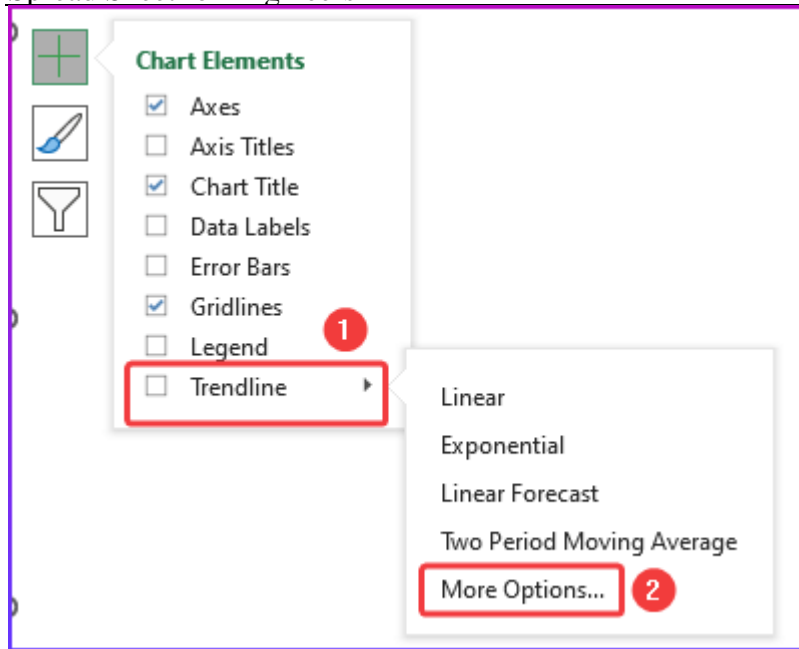
The screenshot shows the Microsoft Excel interface with the 'Insert' tab selected. The 'Scatter' chart gallery is open, and the 'Scatter with Smooth Lines and Markers' option is highlighted with a red box. The chart area contains the following data:

Equation	
X Value	
1	
2	5
3	10
4	17
5	26

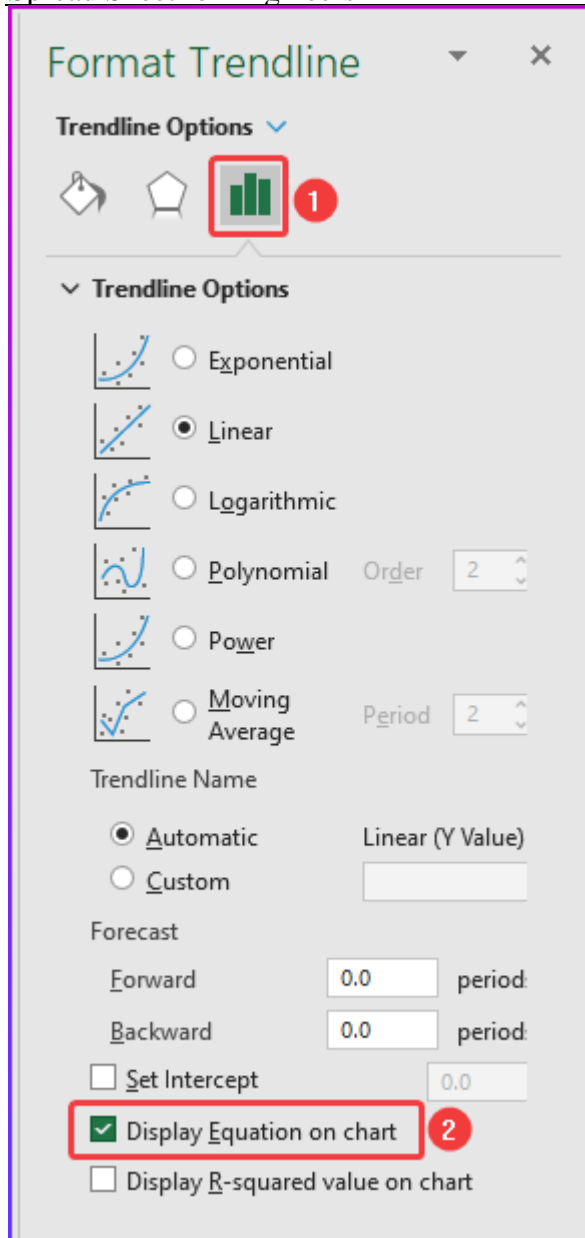
- Thirdly, you will see the chart with the required data in your Excel sheet.
- After that, select your Excel chart and choose the **Chart Elements** icon which is on the top right corner of the chart.



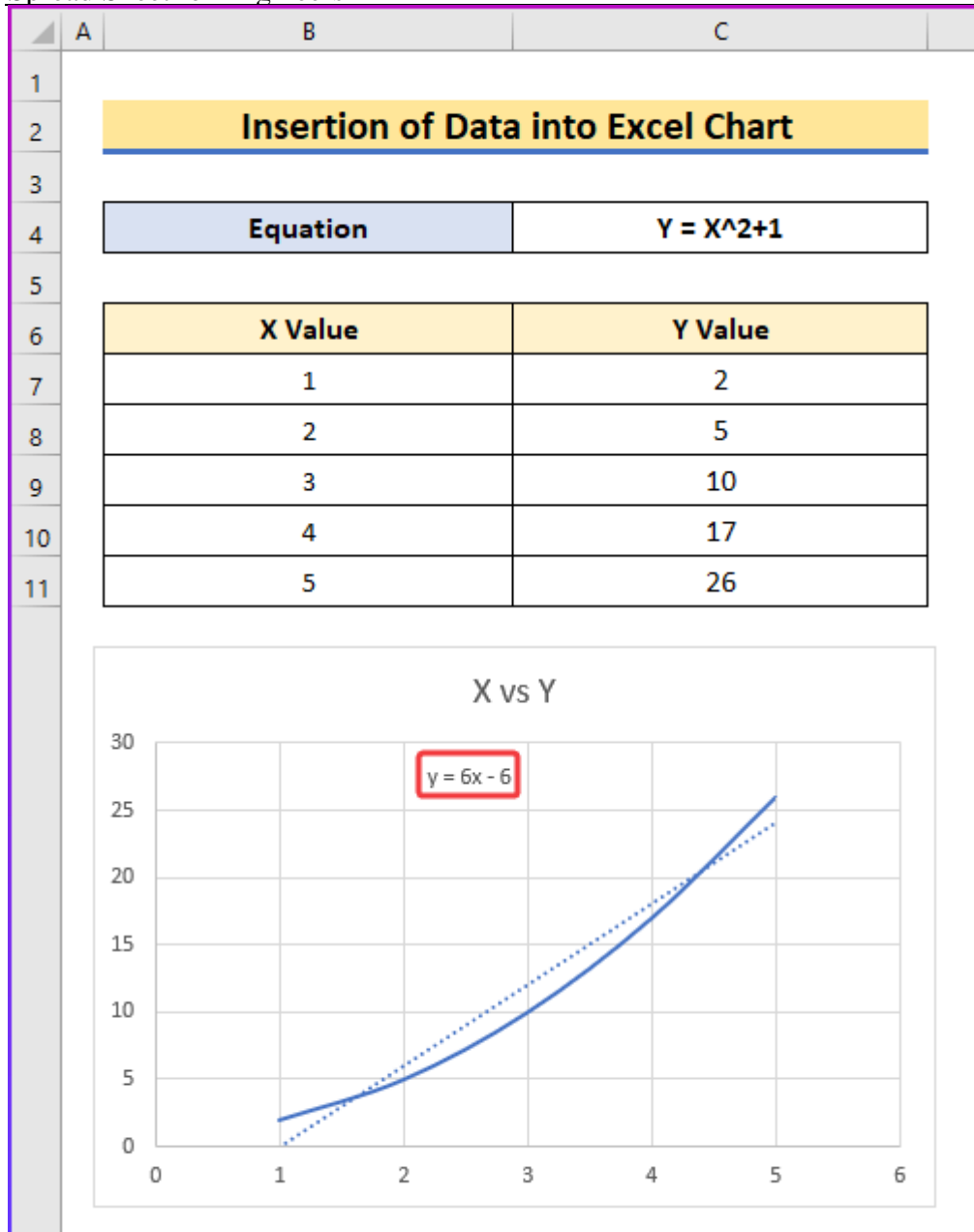
- Fourthly, from the **Chart Elements** command select the **Trendline** dropdown and from there choose **More Options**.



- Consequently, you will see the **Format Trendline** window pane after the previous step and then mark the option **Display Equation on chart**.



- Finally, you will see the consequent equation for this tangent line is $y = 6x - 6$, and by comparing the equation with $y = mx + c$, you can see the slope of this line is 6.



NOTES

- While inserting the data range in **the SLOPE function** formula, remember to insert the values of the **y-axis** in the first place.
- Insert the proper data range while making the Excel chart.
- The **SLOPE** function returns **#DIV/0!** error when any cell of **X-coordinates** or **Y-coordinates** is empty.

EXPERIMENT-5

Date:

Aim: Iterative Solutions Using Excel: Using Goal Seek in Excel, Using the Solver to Find Roots, Finding Multiple Roots, Optimization Using the Solver, Minimization Analysis, Nonlinear Regression Analysis.

Quadratic Equation

A quadratic equation is of the form $ax^2 + bx + c = 0$ where $a \neq 0$. A quadratic equation can be solved by using the quadratic formula. You can also use Excel's Goal Seek feature to solve a quadratic equation.

1. For example, we have the formula $y = 3x^2 - 12x + 9.5$. It's easy to calculate y for any given x. For $x = 1$, $y = 0.5$

	A	B	C	D	E	F	G	H	I
1	x	y							
2	1	0.5							
3									

2. For $x = 2$, $y = -2.5$

	A	B	C	D	E	F	G	H	I
1	x	y							
2	2	-2.5							
3									

3. But what if we want to know x for any given y? For example, $y = 24.5$. We need to solve $3x^2 - 12x + 9.5 = 24.5$. We can solve the quadratic equation $3x^2 - 12x + 9.5 - 24.5 = 0$ by using the quadratic formula.

$$3x^2 - 12x - 15 = 0$$

$$a=3, b=-12, c=-15$$

$$D = b^2 - 4ac = (-12)^2 - 4 * 3 * -15 = 144 + 180 = 324$$

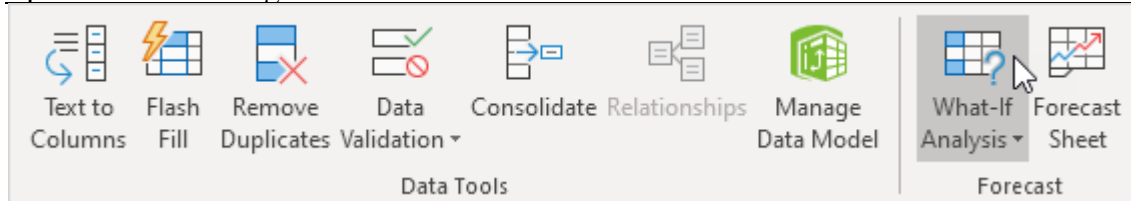
$$x = \frac{-b + \sqrt{D}}{2a} \text{ or } x = \frac{-b - \sqrt{D}}{2a}$$

$$x = \frac{12 + \sqrt{324}}{6} \text{ or } x = \frac{12 - \sqrt{324}}{6}$$

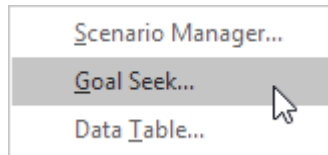
$$x = \frac{12 + 18}{6} \text{ or } x = \frac{12 - 18}{6}$$

$$x = 5 \text{ or } x = -1$$

4. You can use Excel's Goal Seek feature to obtain the exact same result. On the Data tab, in the Forecast group, click What-If Analysis.



5. Click Goal Seek.



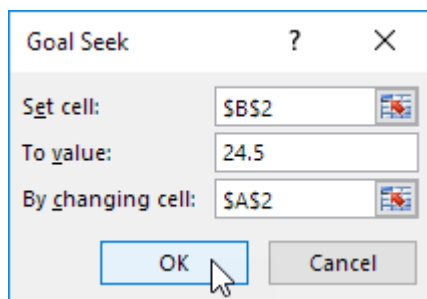
The Goal Seek dialog box appears.

6. Select cell B2.

7. Click in the 'To value' box and type 24.5

8. Click in the 'By changing cell' box and select cell A2.

9. Click OK.



Result.

	A	B	C	D	E	F	G	H	I
1	x	y							
2	4.999976	24.49957							
3									

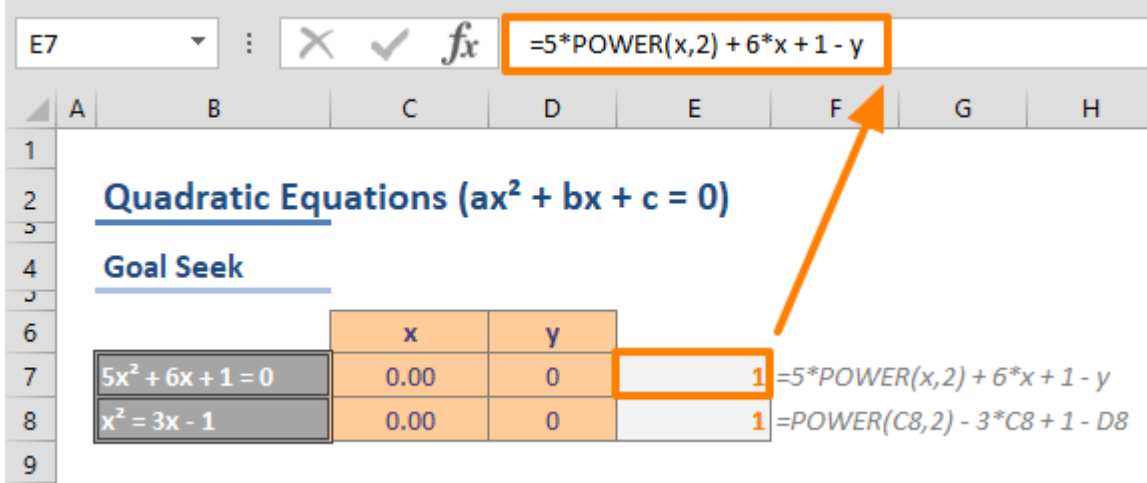
Note: Excel returns the solution $x = 5$. Excel finds the other solution if you start with an x -value closer to $x = -1$. For example, enter the value 0 into cell A2 and repeat steps 5 to 9. To find the roots, set $y = 0$ and solve the quadratic equation $3x^2 - 12x + 9.5 = 0$. In this case, set 'To value' to 0.

Creating a quadratic equation in Excel

A quadratic equation should at least have one squared variable. To do this, you can simply multiply the variable by itself, calculate the 2nd power of the variable using the power operator $^$ or use the **POWER** function as in our example.

The other important part is to refer a cell as variable, x. Our formula uses named range x and y for the unknown variables and the formula result respectively (x is C7 and y is D7).

$$5x^2 + 6x + 1 = 0 \Rightarrow =5*POWER(x,2) + 6*x + 1 - y$$

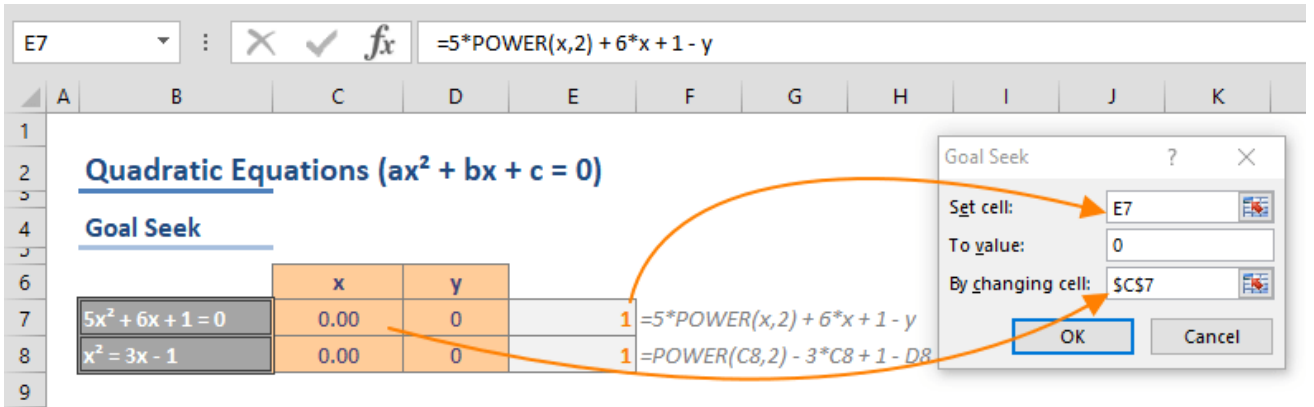


Note: Although adding y into the calculation isn't necessary if you always set it 0, we included it in our example for versatility.

Using Goal Seek to solve quadratic equations in Excel

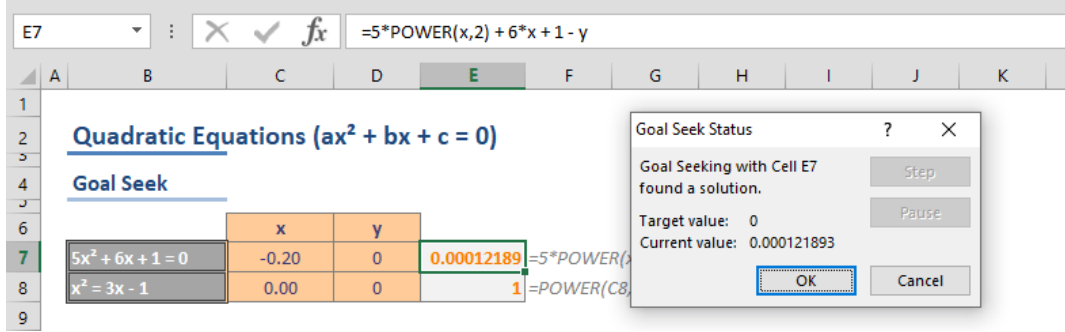
Once the formula is ready in your spreadsheet, it is time to use *Goal Seek* to solve the quadratic function. Follow the steps below to find one of the variables of the equation:

1. Select the cell that contains the formula.
2. Open the **Goal Seek** dialog in **Data > Data Tools > What-If Analysis > Goal Seek**
3. **Set cell** is the formula cell (It should be automatically selected)
4. **To value** should be 0, which is the right end of the equation.
5. Select the cell of the x value to the **By changing cell**
6. Click **OK** to start *Goal Seek*



7. After Excel finished the *Goal Seek* execution, the **Goal Seek Status** dialog will display the calculated value

8. Click **OK** to close the dialog

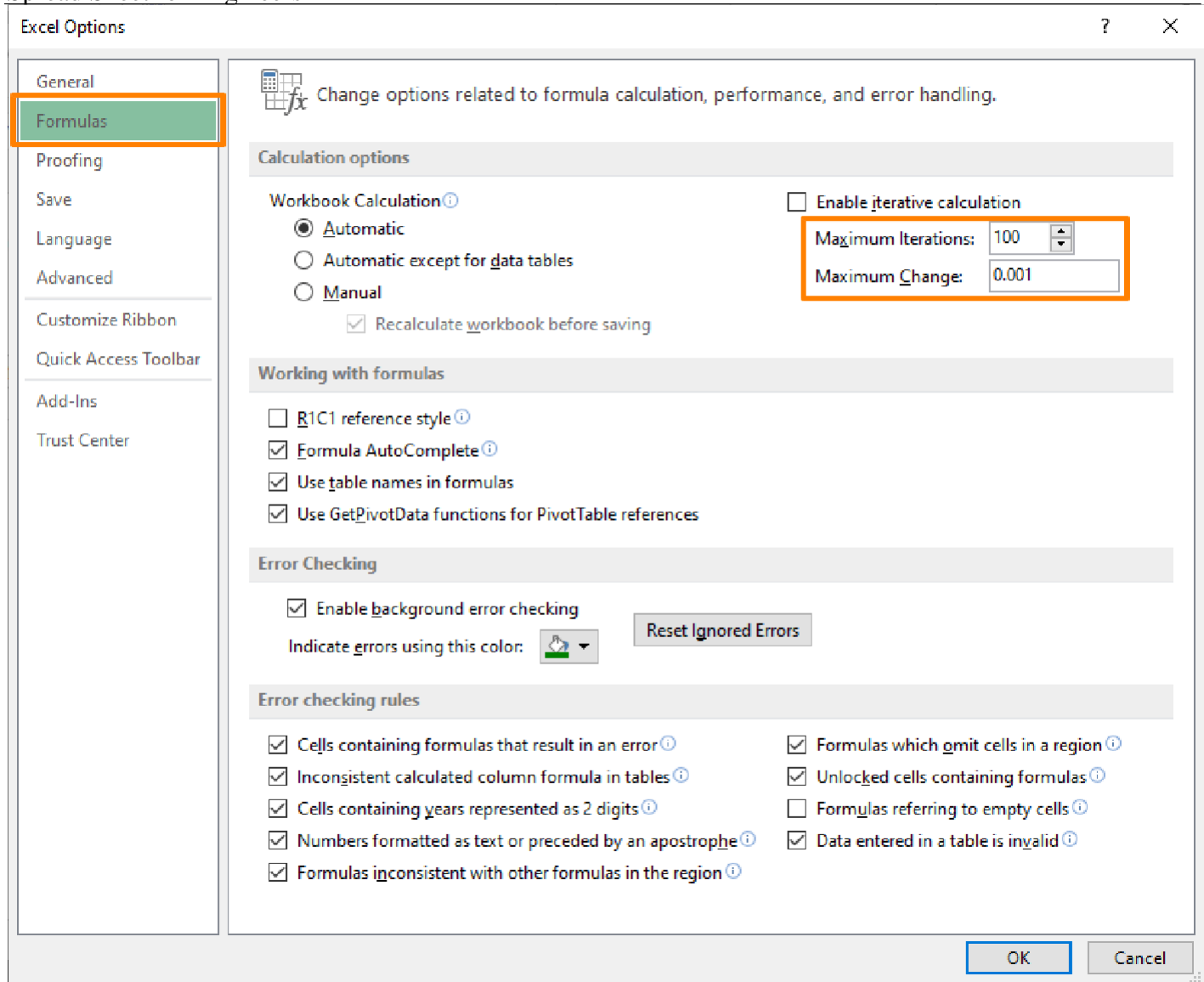


Results of Goal Seek

Although the process is pretty straightforward, there are some downsides to using Goal Seek. As you may have noticed in our screenshots, *Goal Seek* may fail to find the exact value you want. For example, in our example we wanted *Goal Seek* to find a value that makes our formula 0. However, the value makes the formula return a number close to 0, 0.000121893.

If you check the **x** value, you will see a value very close to -0.2, -0.199969528007691. You need to manually enter -0.2 to see the formula return 0.

This difference comes from calculation logic of *Goal Seek*. *Goal Seek* continues searching a certain number of times until it finds a value closer to the target value within the precision limits specified. The default limits for the iteration number and precision value are 100 and 0.001. You can adjust these from **File > Options > Formulas**.



Note: Decrease the **Maximum Change** value to increase the *precision*.

Another important point while using *Goal Seek* is that you need to choose (guess) a starting point for *Goal Seek*. *Goal Seek* finds a single variable, but a quadratic function can have 2 variable options. We found - value when we set 0 to **x**. If you're satisfied with the results, you can change the **x** and run *GoalsSeek* again. For example, setting 10 to **x**, and running *Goal Seek* finds another **x** value, -1.

The screenshot shows an Excel spreadsheet with the following content:

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2		Quadratic Equations ($ax^2 + bx + c = 0$)										
3		Goal Seek										
4												
5												
6												
7		$5x^2 + 6x + 1 = 0$	x	y								
8		$x^2 = 3x - 1$	-1.00	0	0.00011056							
9			0.00	0	1							

Formulas shown in the spreadsheet:

- Cell E7: $=5*POWER(x,2) + 6*x + 1 - y$
- Cell E8: $=POWER(C8,2) - 3*C8 + 1 - D8$

The Goal Seek Status dialog box is open, showing:

- Goal Seeking with Cell E7 found a solution.
- Target value: 0
- Current value: 0.000110559
- Buttons: Step, Pause, OK, Cancel

Step 1

Click "File" from Excel's menu bar.

Step 2

Click "Options." The "Excel Options" window will open.

Step 3

Click "Add-Ins" in the left pane. Click "Solver Add-in" from the right pane.

Step 4

Click the "Go" button. The "Add-Ins" dialog box will open.

Step 5

Check the box next to "Solver Add-in." Click "OK."

Step 6

Type your equation into a cell, using a second cell as a reference. For instance, if your equation is " $4x^3 + 2x^2 - 87 = -1$," type into cell A1, " $=4 * A2^3 + 2 * A2^2 - 87$."

Step 7

Click on the "Data" ribbon.

Step 8

Click "Solver" from the "Analysis" tab. The "Solver Parameters" window will open.

Step 9

Enter the reference of the cell into which you typed the formula in the "Set Objective:" box. In this example, type "A1."

Step 10

Click the "Value of:" button.

Step 11

Enter your target value in the "Value Of:" box. In this example, type "-1."

Step 12

Type the formula's reference cell in the "By Changing Variable Cells:" box. In this example, type "A2."

Step 13

Click "Solve." Excel will change both cells accordingly. In this example, cell A1 will change to "-1.00007," which is very close to "-1." Cell A2 will change to "2.623573," which is a root of the equation.

Optimization with Excel Solver

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Solver is a Microsoft Excel add-in program you can use for optimization in what-if analysis.

According to O'Brien and Marakas, **optimization analysis** is a more complex extension of goal-seeking analysis. Instead of setting a specific target value for a variable, the goal is to find the optimum value for one or more target variables, under certain constraints. Then, one or more other variables are changed repeatedly, subject to the specified constraints, until you discover the best values for the target variables.

In Excel, you can use **Solver** to find an **optimal value** (maximum or minimum, or a certain value) for a formula in one cell called the objective cell, subject to certain constraints or limits, on the values of other formula cells on the worksheet.

This means that the Solver works with a group of cells called decision variables that are used in computing the formulas in the objective and constraint cells. Solver adjusts the values in the decision variable cells to satisfy the limits on constraint cells and produce the result you want for the objective cell.

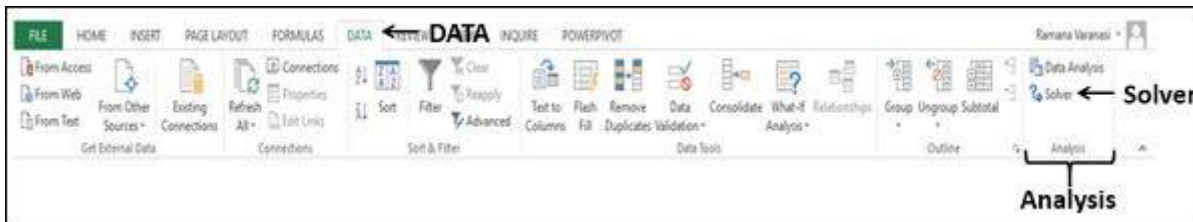
You can use Solver to find optimal solutions for diverse problems such as –

- Determining the monthly product mix for a drug manufacturing unit that maximizes the profitability.
- Scheduling workforce in an organization.
- Solving transportation problems.
- Financial planning and budgeting.

Activating Solver Add-in

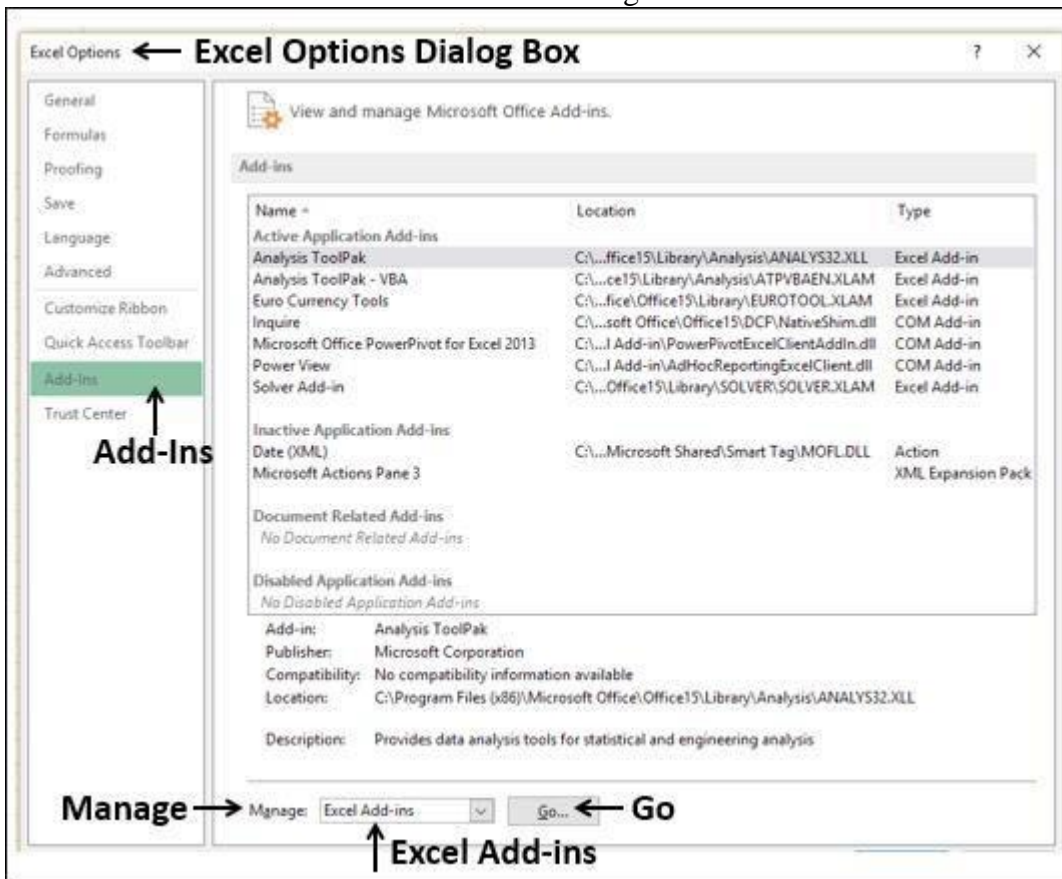
Before you proceed with finding solution for a problem with Solver, ensure that the **Solver Add-in** is activated in Excel as follows –

- Click the **DATA** tab on the Ribbon. The **Solver** command should appear in the Analysis group as shown below.

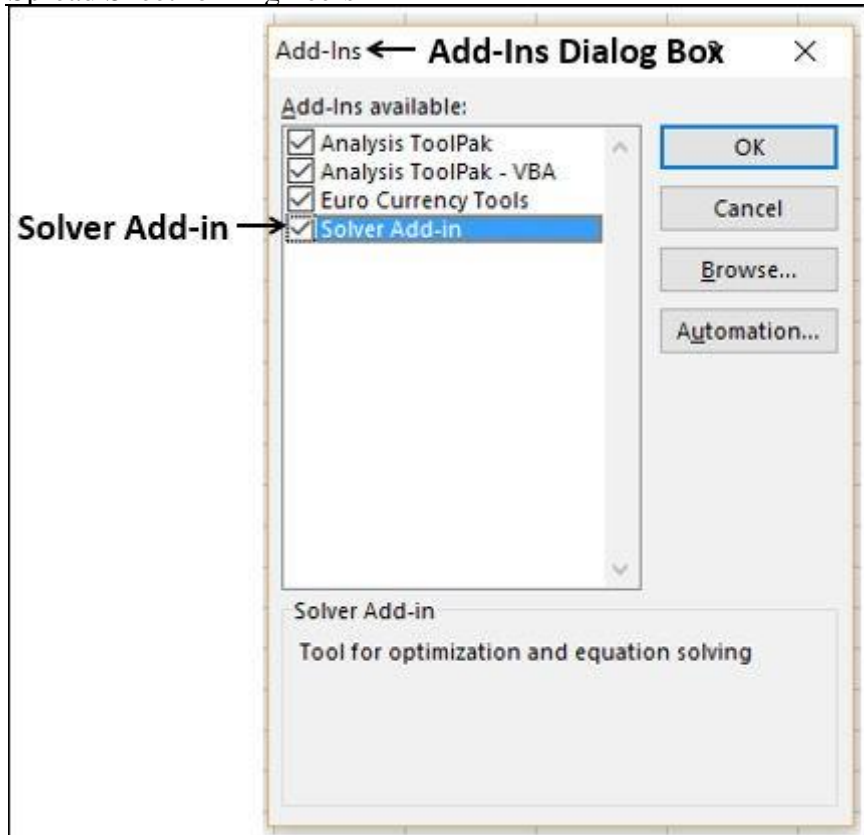


In case you do not find the Solver command, activate it as follows –

- Click the **FILE** tab.
- Click **Options** in the left pane. Excel Options dialog box appears.
- Click **Add-Ins** in the left pane.
- Select **Excel Add-Ins** in the Manage box and click **Go**.



The Add-Ins dialog box appears. Check **Solver Add-in** and click **Ok**. Now, you should be able to find the Solver command on the Ribbon under the **DATA** tab.



Solving Methods used by Solver

You can choose one of the following three solving methods that Excel Solver supports, based on the type of problem –

LP Simplex

Used for linear problems. A **Solver** model is linear under the following conditions –

- The target cell is computed by adding together the terms of the (changing cell)*(constant) form.
- Each constraint satisfies the linear model requirement. This means that each constraint is evaluated by adding together the terms of the (changing cell)*(constant) form and comparing the sums to a constant.

Generalized Reduced Gradient (GRG) Nonlinear

Used for smooth nonlinear problems. If your target cell, any of your constraints, or both contain references to changing cells that are not of the (changing cell)*(constant) form, you have a nonlinear model.

Evolutionary

Used for smooth nonlinear problems. If your target cell, any of your constraints, or both contain references to changing cells that are not of the (changing cell)*(constant) form, you have a nonlinear model.

Understanding Solver Evaluation

The Solver requires the following parameters –

- Decision Variable Cells
- Constraint Cells
- Objective Cells

- Solving Method

Solver evaluation is based on the following –

- The values in the decision variable cells are restricted by the values in the constraint cells.
- The calculation of the value in the objective cell includes the values in the decision variable cells.
- Solver uses the chosen Solving Method to result in the optimal value in the objective cell.

Defining a Problem

Suppose you are analyzing the profits made by a company that manufactures and sells a certain product. You are asked to find the amount that can be spent on advertising in the next two quarters subject to a maximum of 20,000. The level of advertising in each quarter affects the following –

- The number of units sold, indirectly determining the amount of sales revenue.
- The associated expenses, and
- The profit.

You can proceed to define the problem as –

- Find Unit Cost.
- Find the advertising cost per Unit.
- Find Unit Price.

	A	B	C
1			
2		Unit Cost	50
3		Unit Price	100
4		Adv. Cost per Unit	20

Next, set the cells for the required calculations as given below.

	A	B	C	D
1				
2		Unit Cost	50	Total Profit
3		Unit Price	100	=C12+D12
4		Adv. Cost per Unit	20	
5				
6			Quarter1	Quarter2
7		No. of Units Available	400	600
8		Adv. Budget	10000	10000
9		No. of Units Sold	=MIN(C8/C4,C7)	=MIN(D8/C4,D7)
10		Revenue	=C3*C9	=C3*D9
11		Expenses	=C2*C7+C8	=C2*D7+D8
12		Profit	=C10-C11	=D10-D11

Spread Sheet for Engineers

As you can observe, the calculations are done for Quarter1 and Quarter2 that are in consideration are –

- No. of units available for sale in Quarter1 is 400 and in Quarter2 is 600 (cells – C7 and D7).
- The initial values for advertising budget are set as 10000 per Quarter (Cells – C8 and D8).
- No. of units sold is dependent on the advertising cost per unit and hence is budget for the quarter / Adv. Cost per unit. Note that we have used the Min function to take care to see that the no. of units sold in \leq no. of units available. (Cells – C9 and D9).
- Revenue is calculated as Unit Price * No. of Units sold (Cells – C10 and D10).
- Expenses is calculated as Unit Cost * No. of Units Available + Adv. Cost for that quarter (Cells – C11 and D12).
- Profit is Revenue – Expenses (Cells C12 and D12).
- Total Profit is Profit in Quarter1 + Profit in Quarter2 (Cell – D3).

Next, you can set the parameters for Solver as given below –

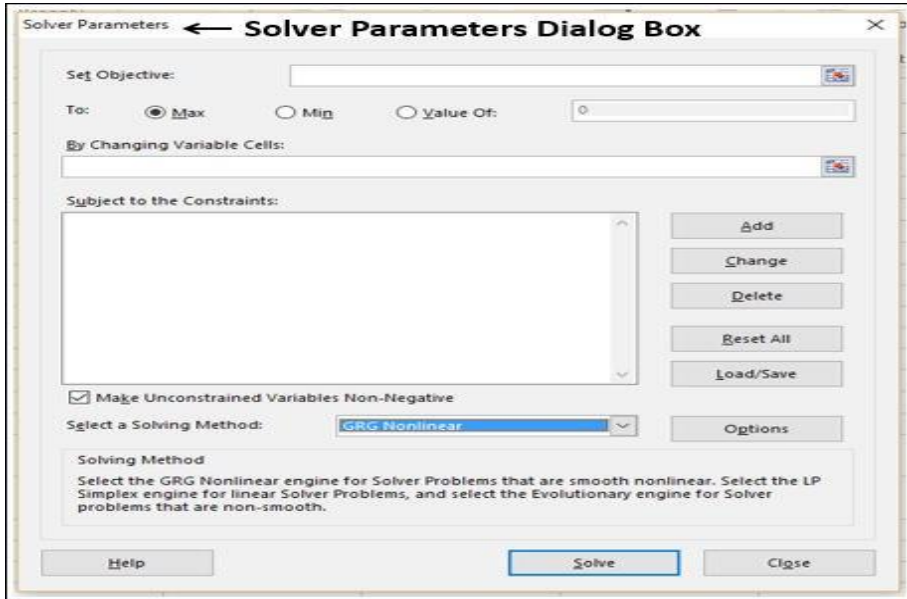
	A	B	C	D
1				
2		Unit Cost	50	Total Profit
3		Unit Price	100	=C12+D12
4		Adv. Cost per Unit	20	
5				
6			Quarter1	Quarter2
7		No. of Units Available	400	600
8		Adv. Budget	10000	10000
9		No. of Units Sold	=MIN(C8/C4,C7)	=MIN(D8/C4,D7)
10		Revenue	=C3*C9	=C3*D9
11		Expenses	=C2*C7+C8	=C2*D7+D8
12		Profit	=C10-C11	=D10-D11
13				
14		Total Adv. Budget	=C8+D8	20000
15		No. of Units sold in Quarter1	=C9	=C7
16		No. of Units sold in Quarter2	=D9	=D7

As you can observe, the parameters for Solver are –

- Objective cell is D3 that contains Total Profit, which you want to maximize.
- Decision Variable cells are C8 and D8 that contain the budgets for the two quarters – Quarter1 and Quarter2.
- There are three Constraint cells - C14, C15 and C16.
 - Cell C14 that contains total budget is to set the constraint of 20000 (cell D14).
 - Cell C15 that contains the no. of units sold in Quarter1 is to set the constraint of \leq no. of units available in Quarter1 (cell D15).
 - Cell C16 that contains the no. of units sold in Quarter2 is to set the constraint of \leq no. of units available in Quarter2 (cell D16).

The next step is to use Solver to find the solution as follows –

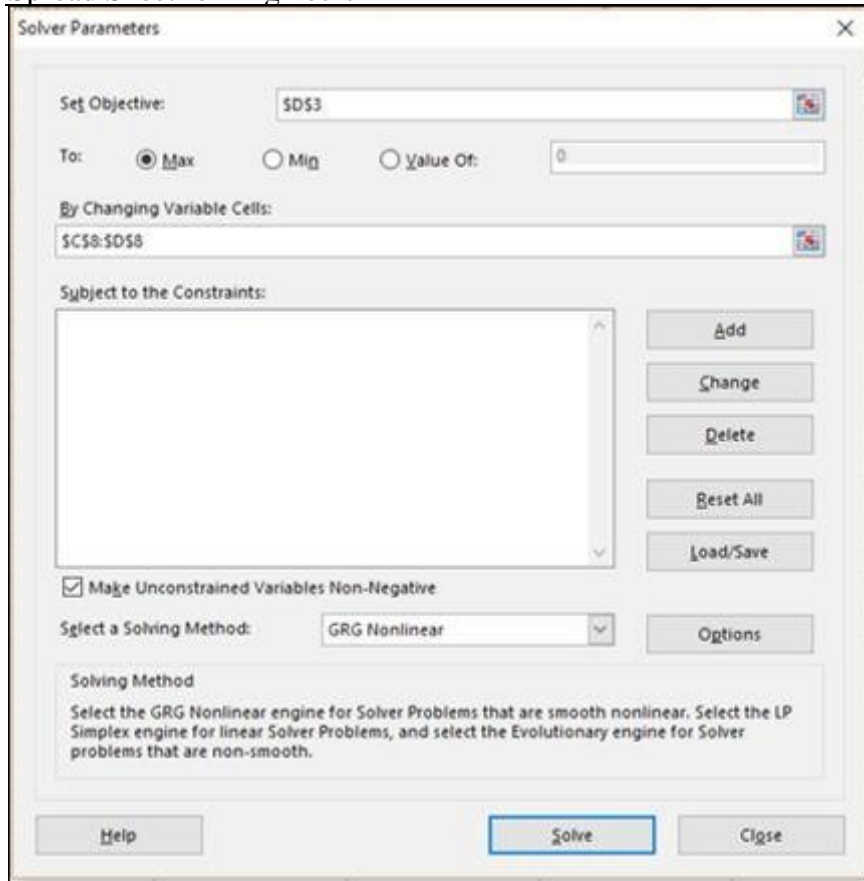
Step 1 – Go to DATA > Analysis > Solver on the Ribbon. The Solver Parameters dialog box appears.



Step 2 – In the Set Objective box, select the cell D3.

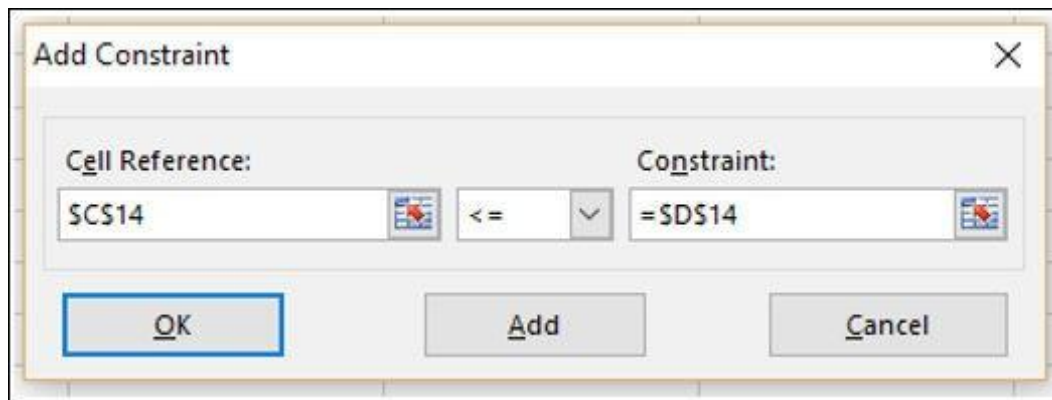
Step 3 – Select Max.

Step 4 – Select range C8:D8 in the **By Changing Variable Cells** box.

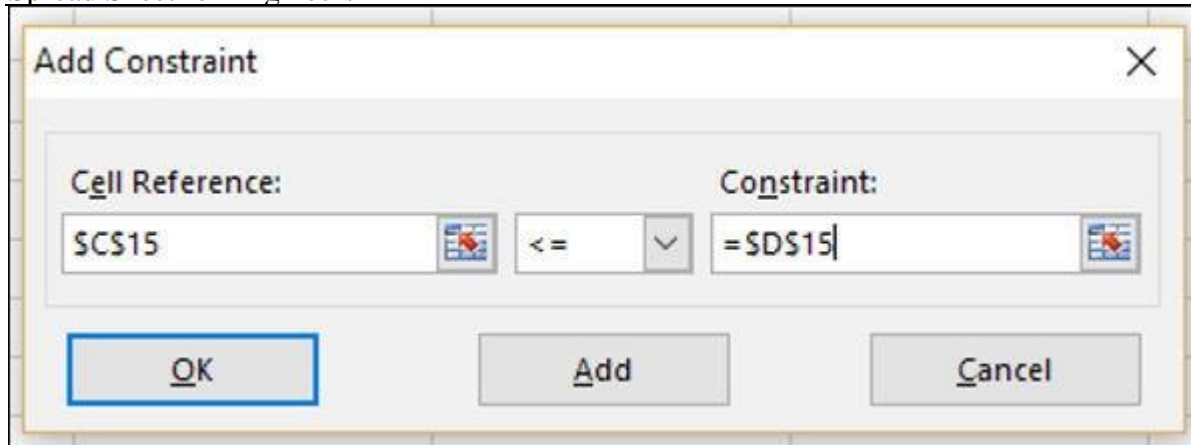


Step 5 – Next, click the Add button to add the three constraints that you have identified.

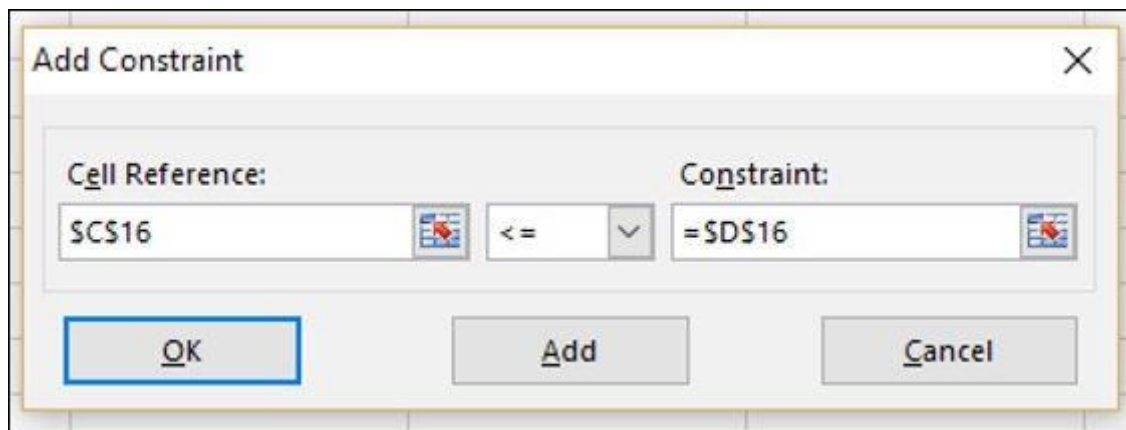
Step 6 – The Add Constraint dialog box appears. Set the constraint for total budget as given below and click Add.



Step 7 – Set the constraint for total no. of units sold in Quarter1 as given below and click Add.

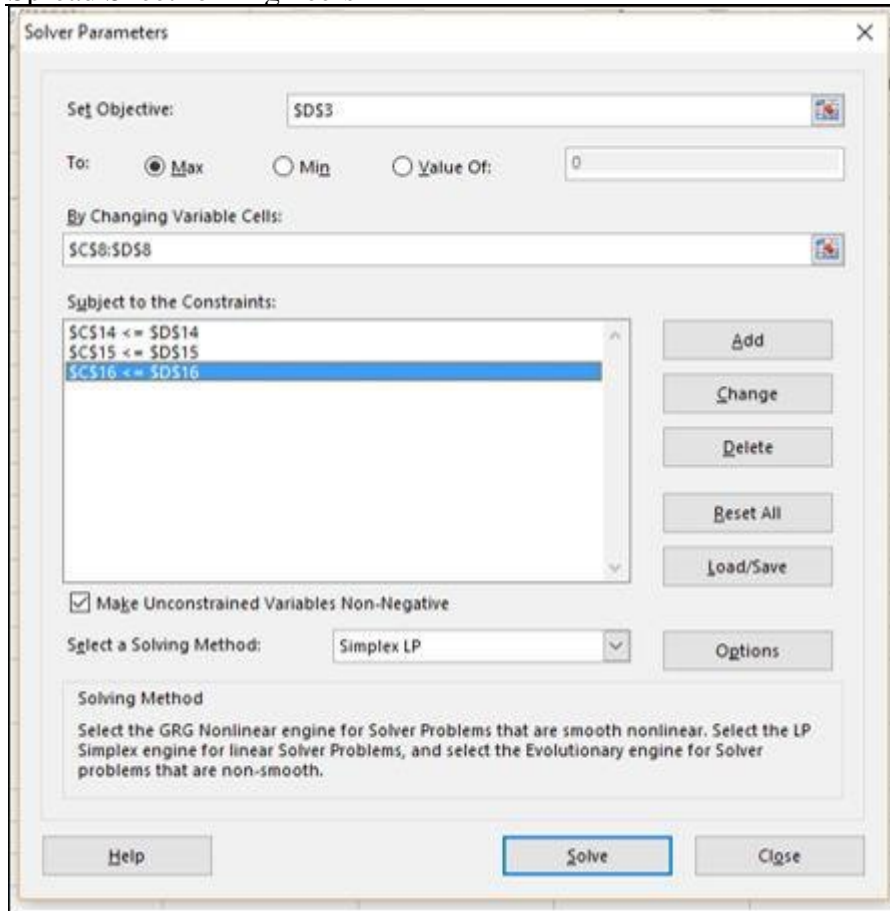


Step 8 – Set the constraint for total no. of units sold in Quarter2 as given below and click OK.

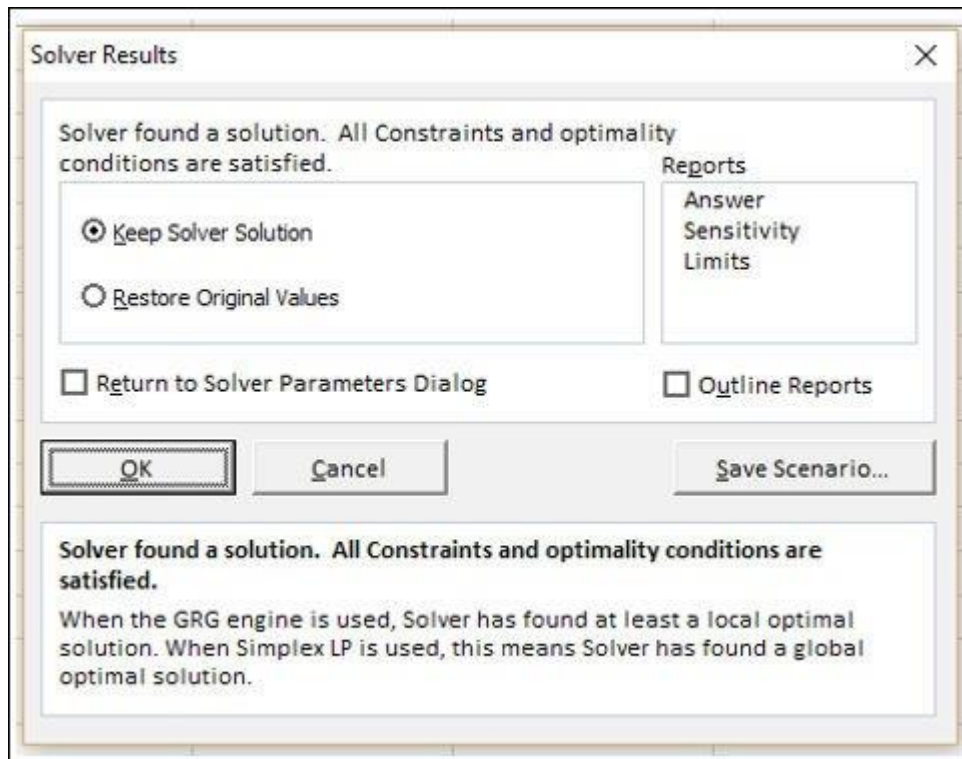


The Solver Parameters dialog box appears with the three constraints added in box –Subject to the Constraints.

Step 9 – In the **Select a Solving Method** box, select Simplex LP.



Step 10 – Click the Solve button. The Solver Results dialog box appears. Select **Keep Solver Solution** and click OK.



The results will appear in your worksheet.

	A	B	C	D
1				
2		Unit Cost	50	Total Profit
3		Unit Price	100	30000
4		Adv. Cost per Unit	20	
5				
6			Quarter1	Quarter2
7		No. of Units Available	400	600
8		Adv. Budget	8000	12000
9		No. of Units Sold	400	600
10		Revenue	40000	60000
11		Expenses	28000	42000
12		Profit	12000	18000
13				
14		Total Adv. Budget	20000	20000
15		No. of Units sold in Quarter1	400	400
16		No. of Units sold in Quarter2	600	600

As you can observe, the optimal solution that produces maximum total profit, subject to the given constraints, is found to be the following –

- Total Profit – 30000.
- Adv. Budget for Quarter1 – 8000.
- Adv. Budget for Quarter2 – 12000.

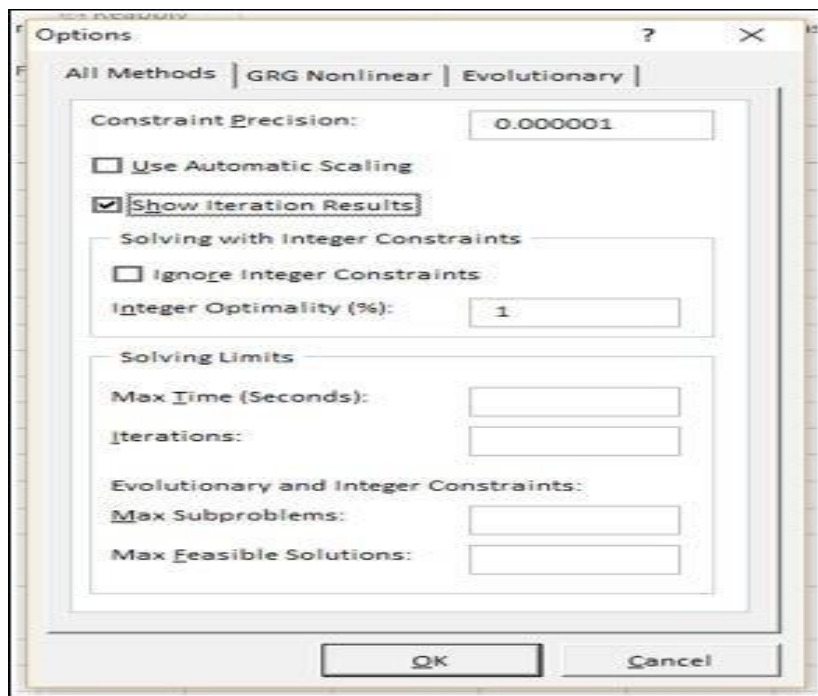
Stepping through Solver Trial Solutions

You can step through the Solver trial solutions, looking at the iteration results.

Step 1 – Click the Options button in the Solver Parameters dialog box.

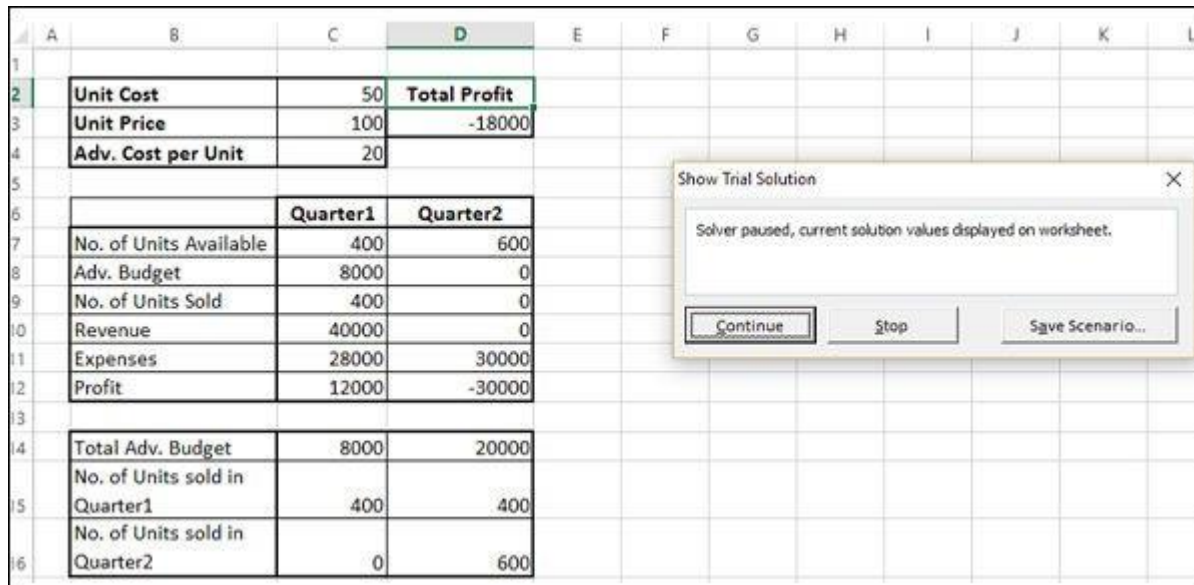
The **Options** dialog box appears.

Step 2 – Select the Show Iteration Results box and click OK.



Step 3 – The **Solver Parameters** dialog box appears. Click **Solve**.

Step 4 – The **Show Trial Solution** dialog box appears, displaying the message - **Solver paused, current solution values displayed on worksheet**.



As you can observe, the current iteration values are displayed in your working cells. You can either stop the Solver accepting the current results or continue with the Solver from finding solution in further steps.

Step 5 – Click **Continue**.

The **Show Trial Solution** dialog box appears at every step and finally after the optimal solution is found, Solver Results dialog box appears. Your worksheet is updated at every step, finally showing the result values.

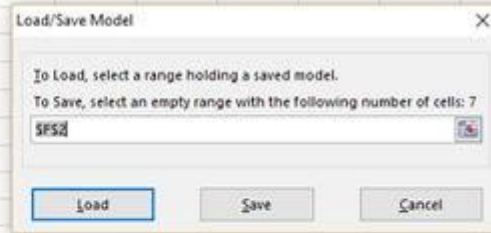
Saving Solver Selections

You have the following saving options for the problems that you solve with Solver –

- You can save the last selections in the Solver Parameters dialog box with a worksheet by saving the workbook.
- Each worksheet in a workbook can have its own Solver selections, and all of them will be saved when you save the workbook.
- You can also define more than one problem in a worksheet, each with its own Solver selections. In such a case, you can load and save problems individually with the Load/Save in the Solver Parameters dialog box.
 - Click the **Load/Save** button. The Load/Save dialog box appears.
 - To save a problem model, enter the reference for the first cell of a vertical range of empty cells in which you want to place the problem model. Click Save.

Spread Sheet for Engineers

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2		Unit Cost	50	Total Profit									
3		Unit Price	100	20000									
4		Adv. Cost per Unit	20										
5													
6			Quarter1	Quarter2									
7		No. of Units Available	400	600									
8		Adv. Budget	10000	10000									
9		No. of Units Sold	400	500									
10		Revenue	40000	50000									
11		Expenses	30000	40000									
12		Profit	10000	10000									
13													
14		Total Adv. Budget	20000	20000									
15		No. of Units sold in Quarter1	400	400									
16		No. of Units sold in Quarter2	500	600									



- The problem model (the Solver Parameters set) appears starting at the cell that you have given as the reference.

	A	B	C	D	E	F
1						
2		Unit Cost	50	Total Profit		20000
3		Unit Price	100	20000		2
4		Adv. Cost per Unit	20			TRUE
5						TRUE
6			Quarter1	Quarter2		TRUE
7		No. of Units Available	400	600		32767
8		Adv. Budget	10000	10000		0
9		No. of Units Sold	400	500		
10		Revenue	40000	50000		
11		Expenses	30000	40000		
12		Profit	10000	10000		
13						
14		Total Adv. Budget	20000	20000		
15		No. of Units sold in Quarter1	400	400		
16		No. of Units sold in Quarter2	500	600		

- To load a problem model, enter the reference for the entire range of cells that contains the problem model. Then, click on the Load button.

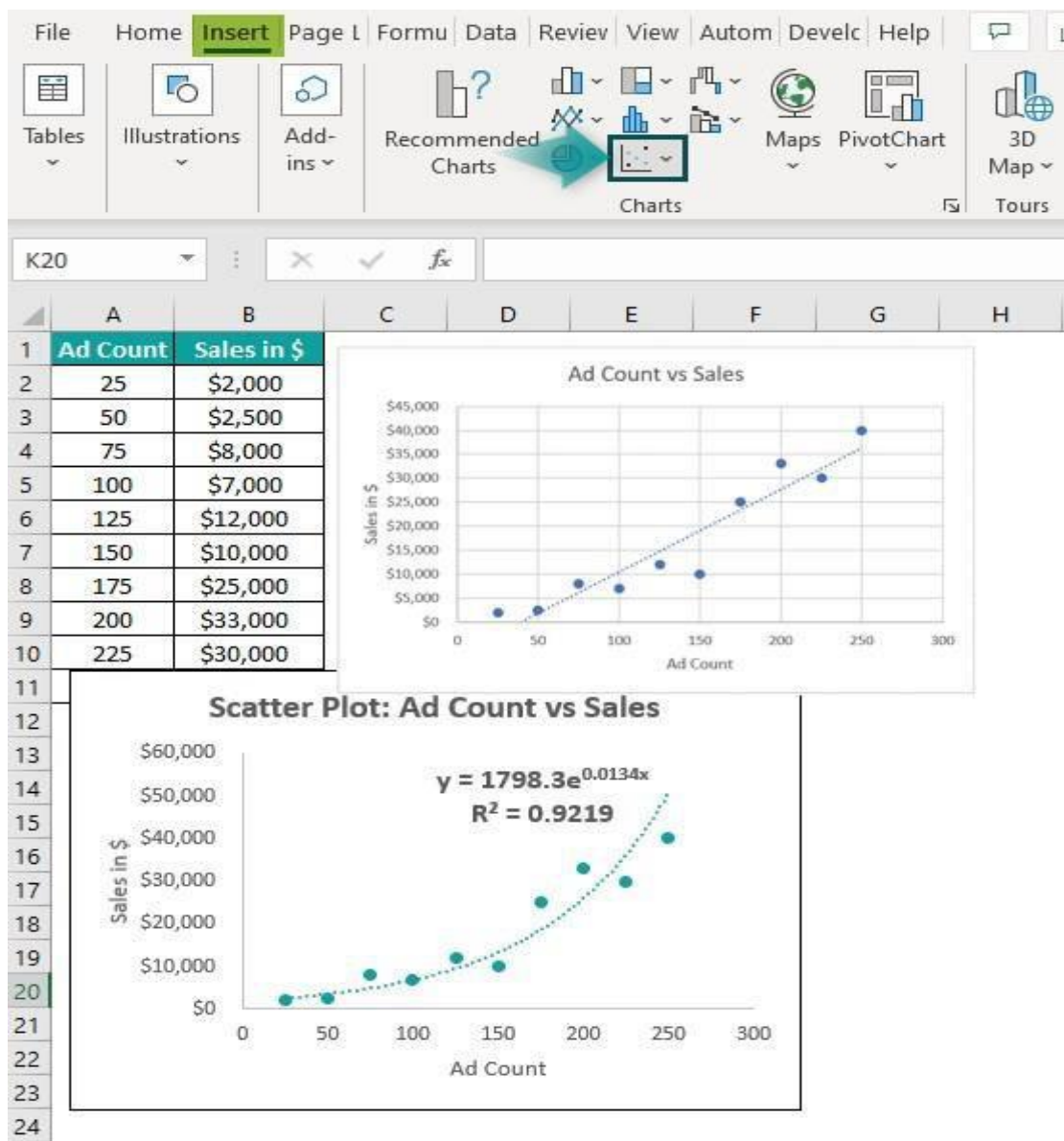
What Is Non-linear Regression In Excel?

Non-linear regression in Excel is a statistical method used to find the nonlinear relationship between one dependent variable and independent continuous variables. Users can use the non-linear regression in a worksheet to fit the data to a model and represent it as a mathematical equation.

For example, the table below shows the ad counts and the sales they generated.

	A	B
1	Ad Count	Sales in \$
2	25	\$2,000
3	50	\$2,500
4	75	\$8,000
5	100	\$7,000
6	125	\$12,000
7	150	\$10,000
8	175	\$25,000
9	200	\$33,000
10	225	\$30,000
11	250	\$40,000
12		

Suppose the requirement is to **calculate nonlinear regression in Excel** for the above data. Then, we can use the **Scatter** plot from the **Insert** tab to achieve the required outcome.



The ad count is the independent variable, and sales are the dependent variable in the above example.

And plotting a Scatter chart for the two variables and inserting a linear trendline, as shown in the first plot, shows a nonlinear relationship between the two parameters. In other words, the sales do not vary linearly with the ad count.

Thus, we must choose the appropriate trendline to achieve the required **nonlinear regression curve in Excel**. In this case, we pick the **Exponential** trendline, as shown in the second plot. And hence, we obtain the exponent-based nonlinear regression equation relating the two specified variables.

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- [What Is Non-linear Regression In Excel?](#)
 - [Explanations & Uses](#)
 - [How To Do Non-linear Regression In Excel?](#)
 - [Examples](#)
 - [Example #1](#)
 - [Example #2](#)
 - [Example #3](#)
 - [Important Things To Note](#)
 - [Frequently Asked Questions](#)
 - [Download Template](#)
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Key Takeaways

- The non-linear regression in Excel is a regression technique. It exhibits the nonlinear relationship between the response (dependent variable) and predictors (independent variables).
- Users can use the nonlinear regression method to evaluate if the regression line fits the data. It helps review the relationship between the dependent variable and one or more independent variables and reckon how well the model fits the data.
- We can use the **Trendline Options** from the **Trendline Format** window to determine the trendline curve that best fits the model to the data. And we can use the above mentioned option, **LINEST()**, or **Regression** from the **Data Analysis ToolPak** to obtain the nonlinear regression equation.

Explanations & Uses

Nonlinear regression in Excel statistically generates a curve depicting the nonlinear relationship between the specified variables or parameters. And Excel uses the nonlinear least square regression method to calculate nonlinear regression equations.

The technique is more accurate and offers flexibility, allowing one to estimate diverse curves with complex equations that best fit the given data.

Furthermore, this regression method helps evaluate if the predicted model fits the given data well and satisfies the analysis assumptions.

The uses of non-linear regression in Excel are as follows:

Spread Sheet for Engineers

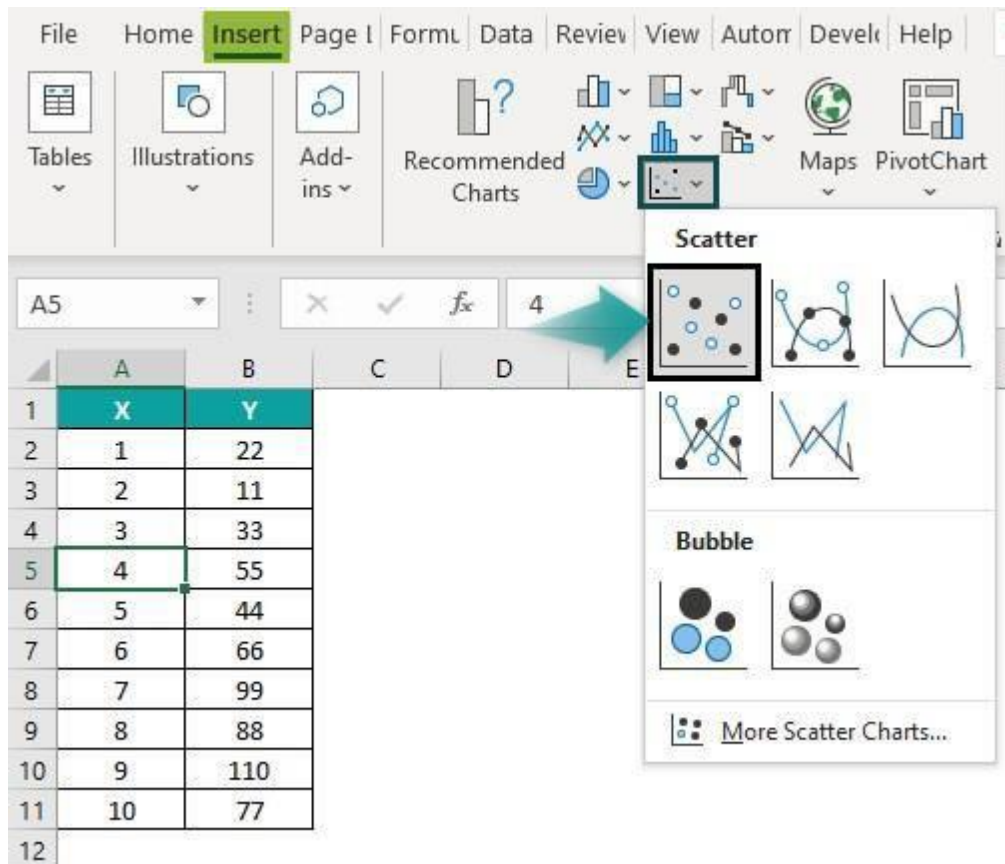
- Financial modeling and price fluctuations over time.
- Logistic price variation model for estimating untouched market prices.
- Predicting and forecasting in agriculture, finance, AI, and machine learning domains.
- Dose-response research in biological sciences.

How To Do Non-linear Regression In Excel?

We can use non-linear regression in Excel by following the below steps:

1. Plot a **Scatter** plot for the given data from the **Insert** tab.
2. Insert a linear trendline to confirm the nonlinear relationship between the given variables.
3. Once confirmed, pick the best-fitting trendline to obtain the required **Excel nonlinear regression formula** or equation.
4. Thus, now we can perform the required nonlinear regression analysis.

Click on a cell in the table of dependent and independent variables' data or select the entire table range. And then, select the **Insert** tab – Pick the **Scatter (X, Y) or Bubble Chart** option – Choose the **Scatter** chart.

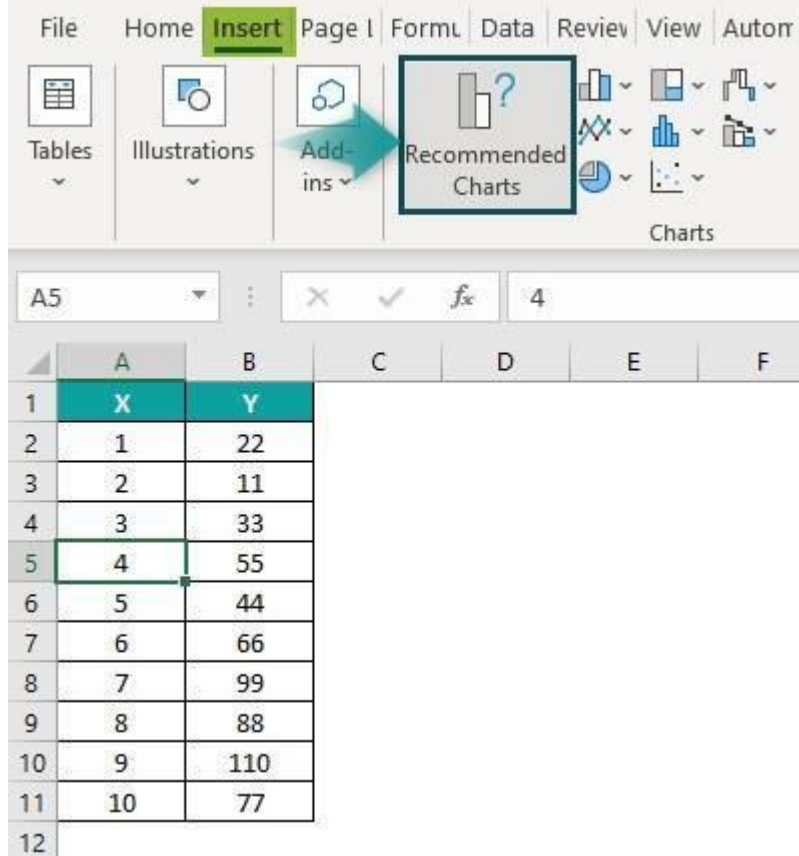


The screenshot shows the Microsoft Excel interface with the **Insert** tab selected. The **Charts** group is active, and the **Scatter** chart type is chosen. The chart options menu is open, displaying various chart styles. A green arrow points from the **Scatter** icon in the menu to the **Scatter** icon in the **Charts** group. The background shows a spreadsheet with data in columns X and Y.

	X	Y
1	1	22
2	2	11
3	3	33
4	4	55
5	5	44
6	6	66
7	7	99
8	8	88
9	9	110
10	10	77

[Alternatively, we can click on a cell in the table of dependent and independent variables' data or select the entire table range. And then, select the **Insert** tab – Pick **Recommended Charts** option.

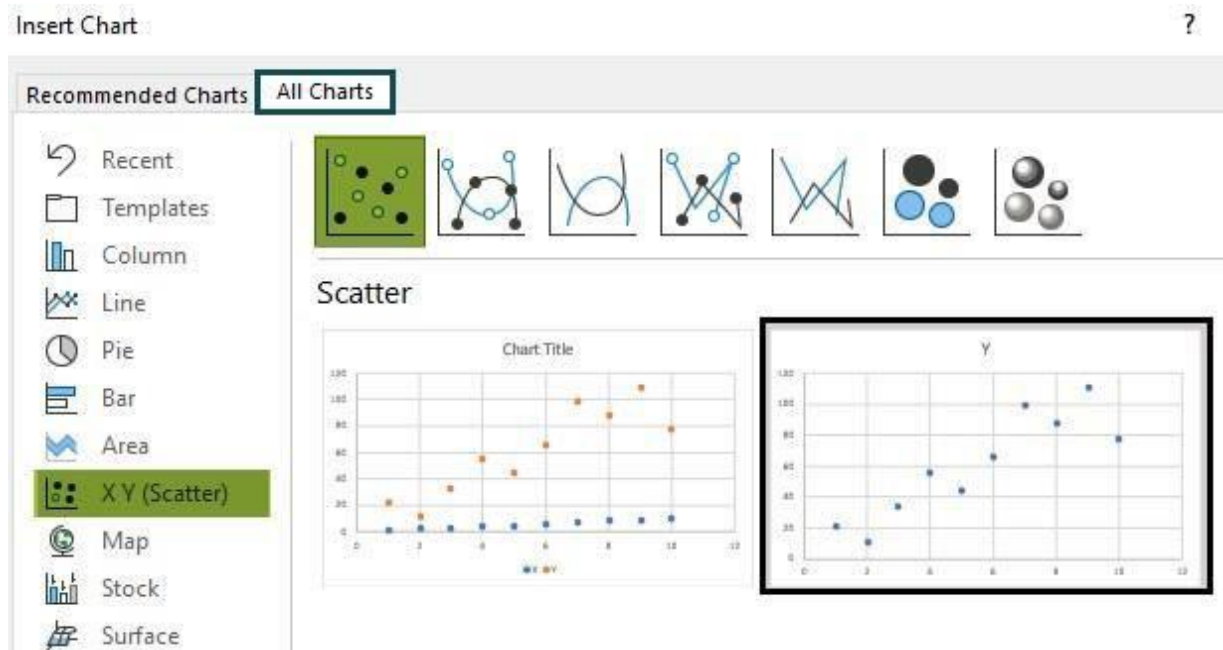
Spread Sheet for Engineers



	A	B	C	D	E	F
1	X	Y				
2	1	22				
3	2	11				
4	3	33				
5	4	55				
6	5	44				
7	6	66				
8	7	99				
9	8	88				
10	9	110				
11	10	77				
12						

The **Insert Chart** window opens.

Go to **All Charts** tab – Pick **X Y (Scatter)** chart – Choose **Scatter** chart – Pick the appropriate Scatter chart from the provided options.



Insert Chart ?

Recommended Charts All Charts

Recent
Templates
Column
Line
Pie
Bar
Area
XY (Scatter)
Map
Stock
Surface

Scatter

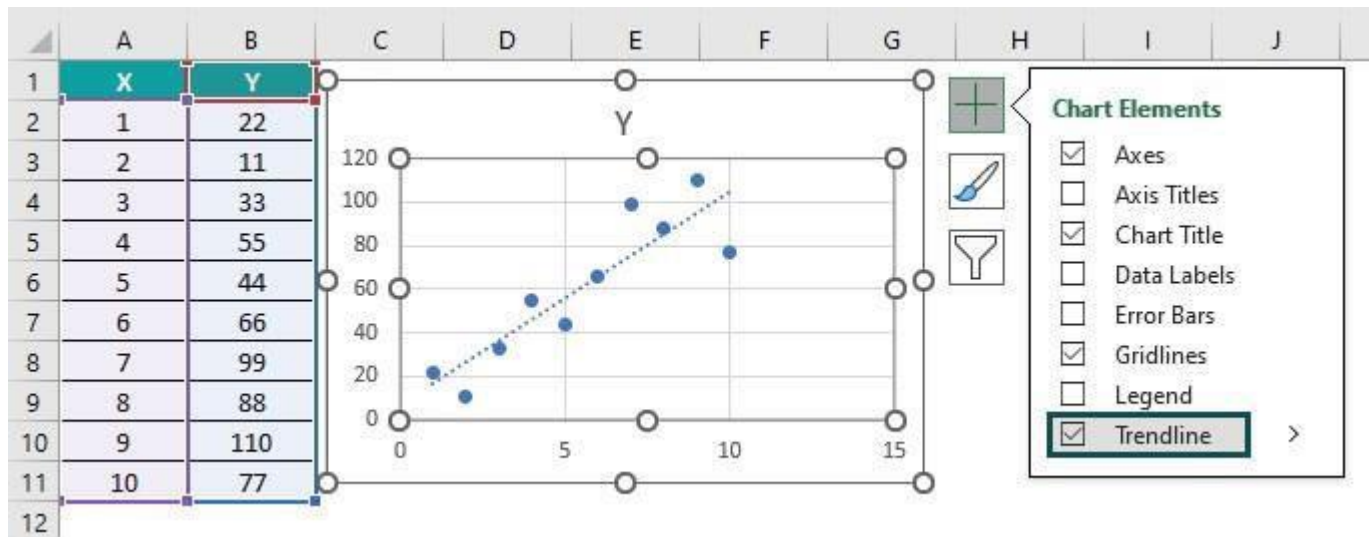
ChartTitle

Y

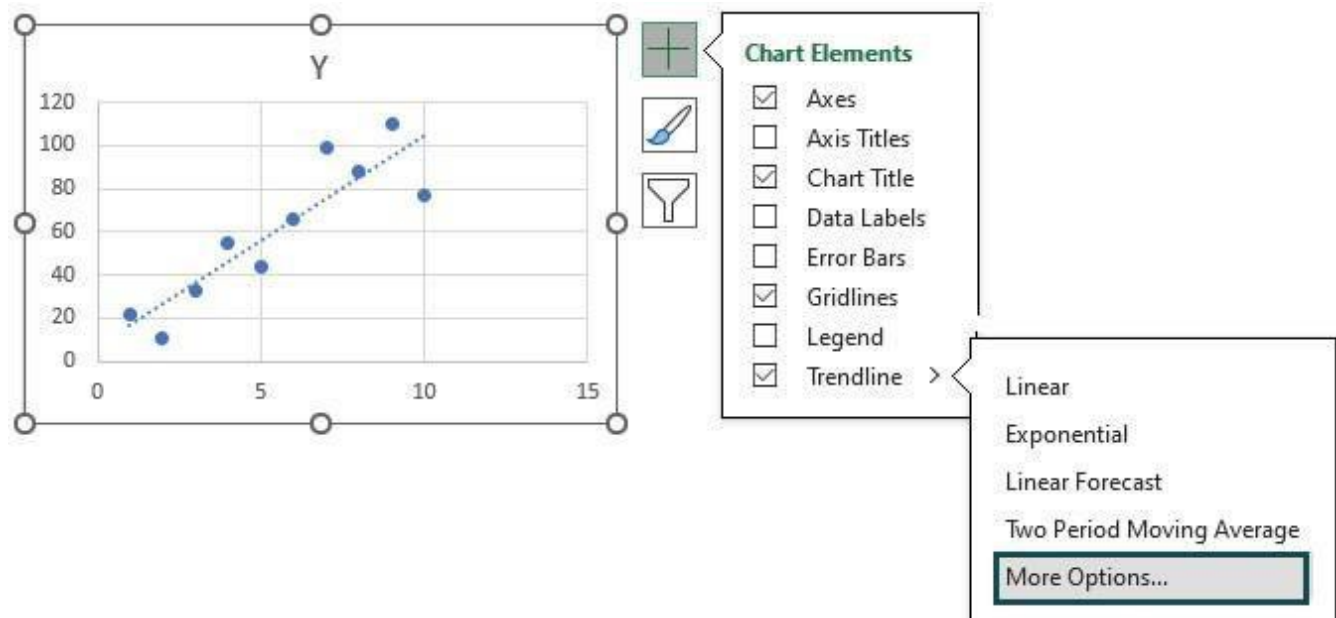
And clicking **OK** will give us the Scatter chart to **calculate nonlinear regression in Excel** and perform the required analysis.]

Spread Sheet for Engineers

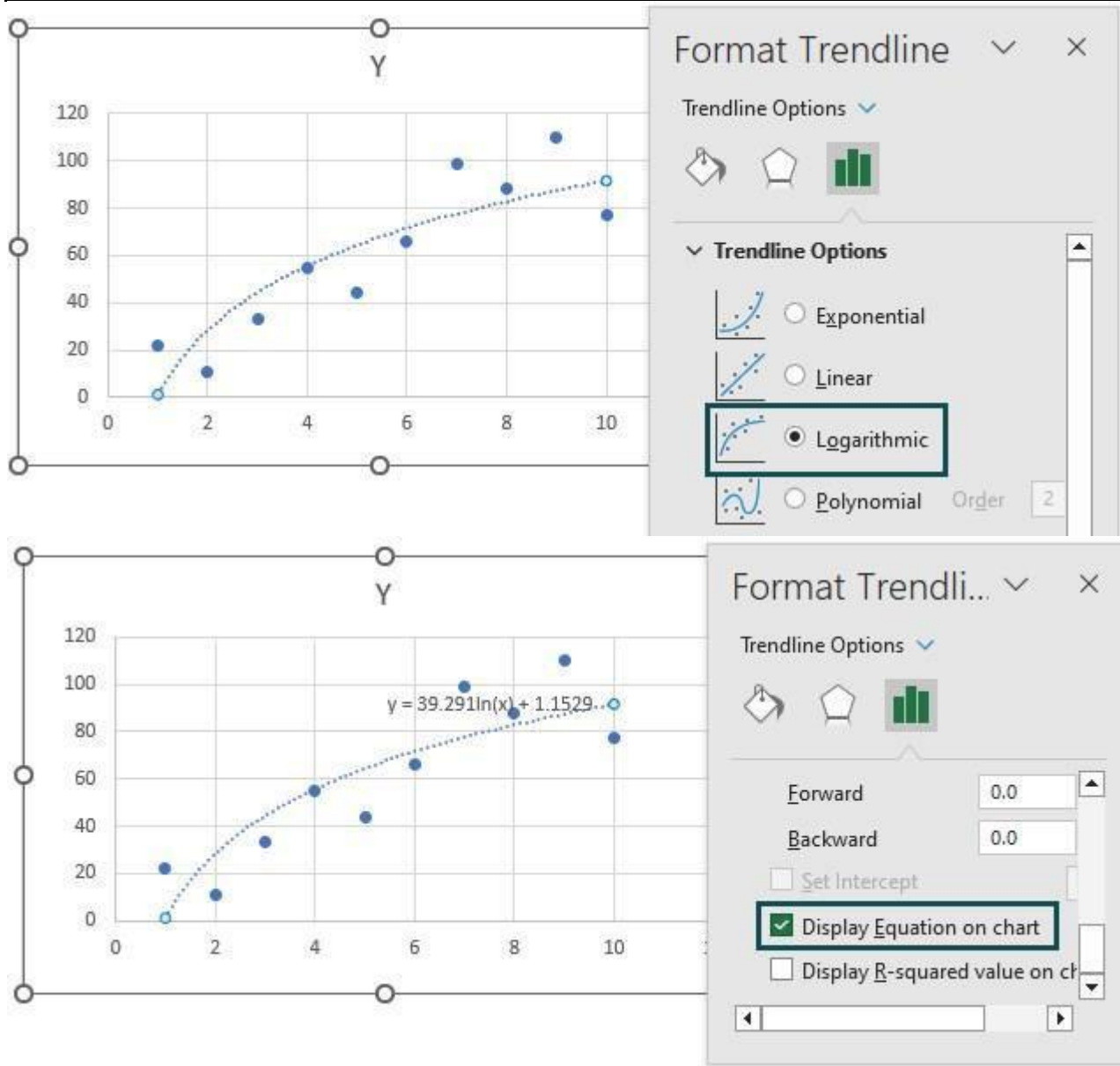
And then, click the **Chart Elements** option – Enable the **Trendline** option to confirm the nonlinear relation between the two variables.



Next, click the **Chart Elements** option – Click **Trendline** right arrow – Pick **More Options**.



The **Format Trendline** pane will open, where we can set the appropriate settings to achieve the **nonlinear regression curve in Excel** with the formula required for analysis.



Let us see the above steps in detail with an example.

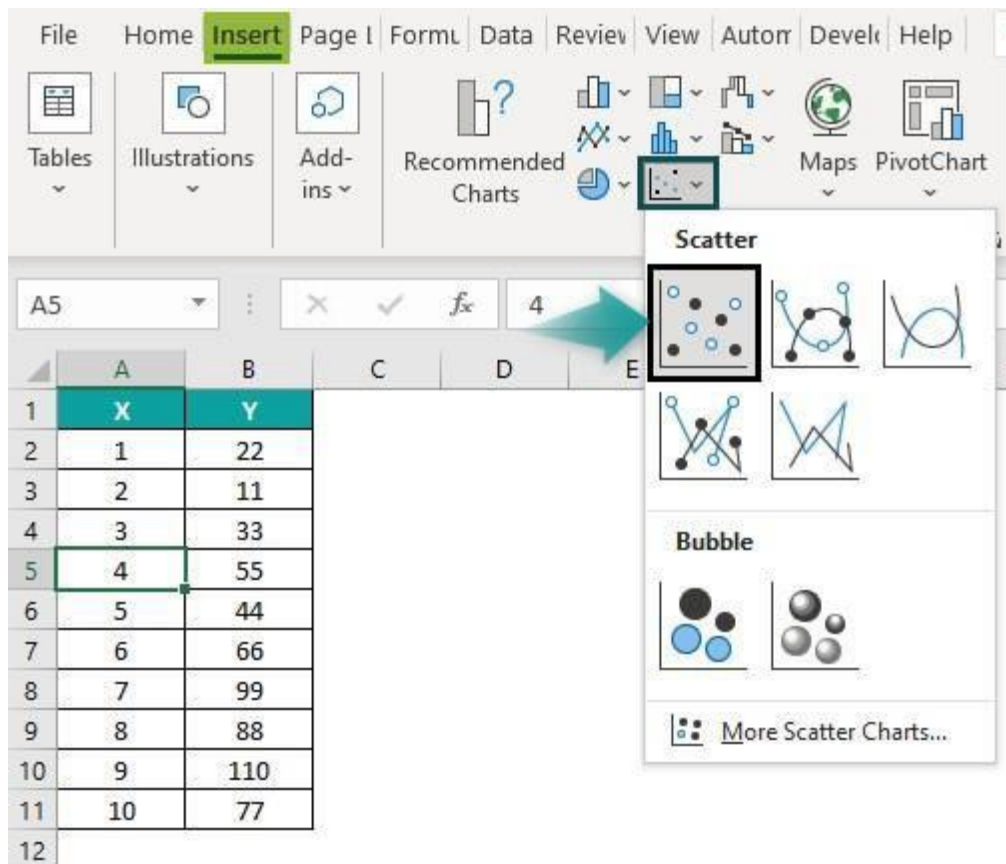
#Basic Example

The table below shows the observations of two parameters, X and Y.

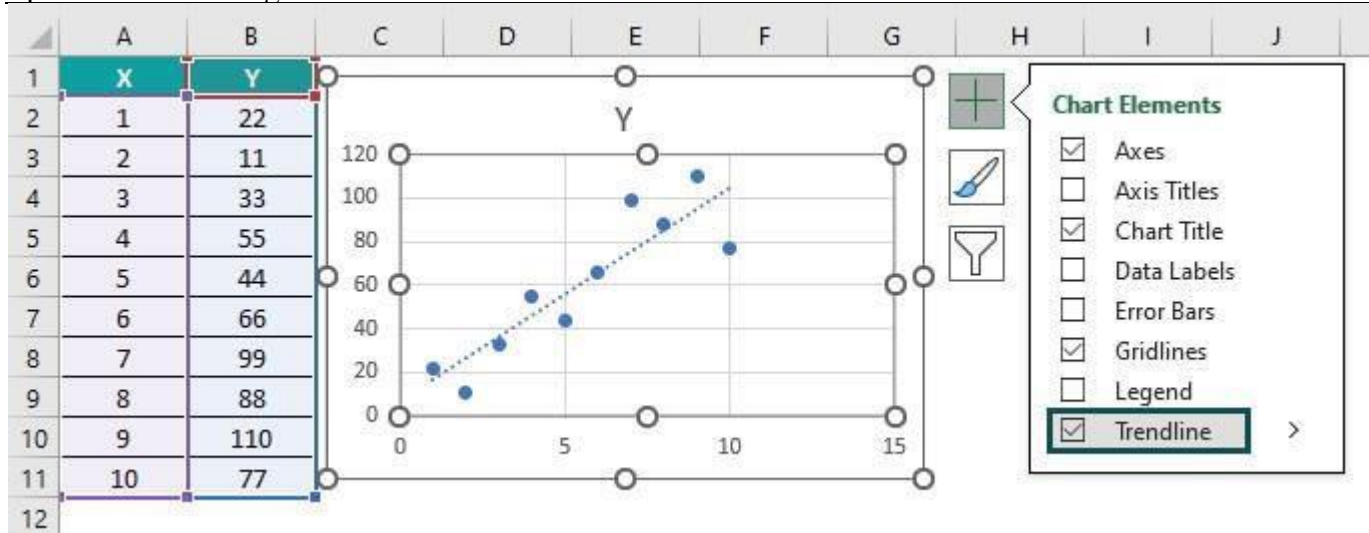
	A	B
1	X	Y
2	1	22
3	2	11
4	3	33
5	4	55
6	5	44
7	6	66
8	7	99
9	8	88
10	9	110
11	10	77
12		

Suppose the requirement is to confirm the non-linear relationship between the two variables. Then, the steps are as follows:

Step 1: To start with, click on a cell in the given table, and then, follow the path **Insert – Scatter (X, Y) or Bubble Chart – Scatter** chart to visualize the given data in a chart format.



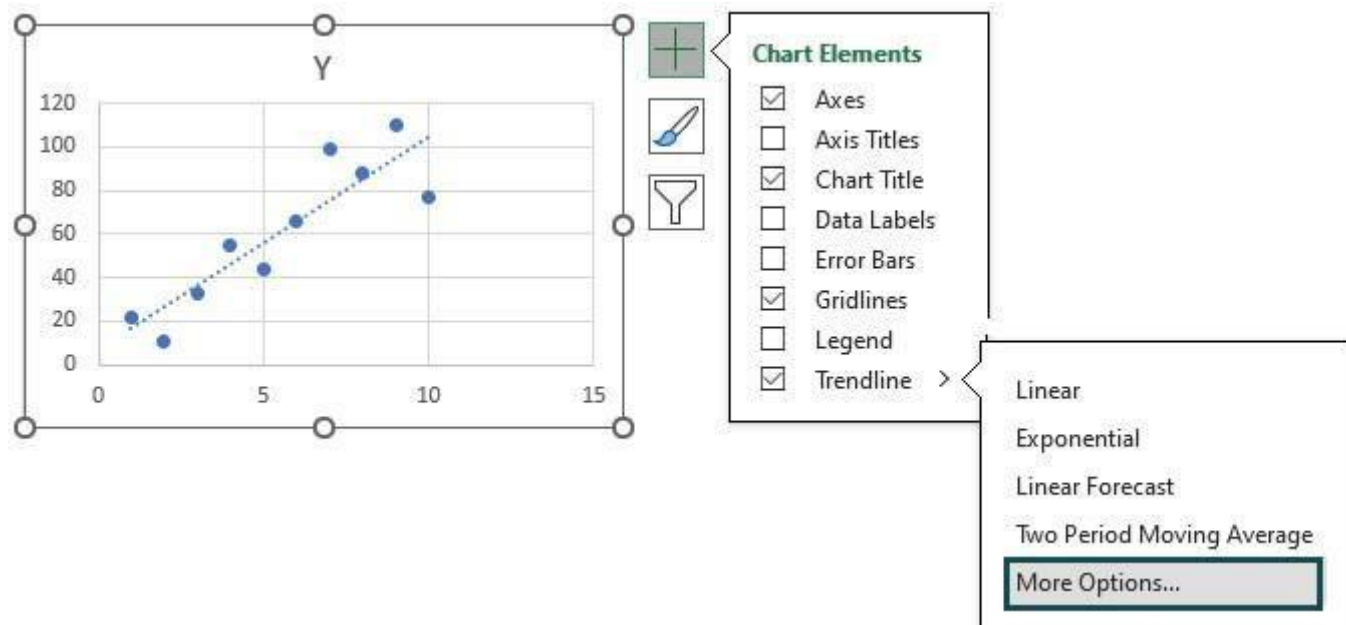
Step 2: Next, click the chart area to enable the **Chart Elements** option, and then, check the **Trendline** box.



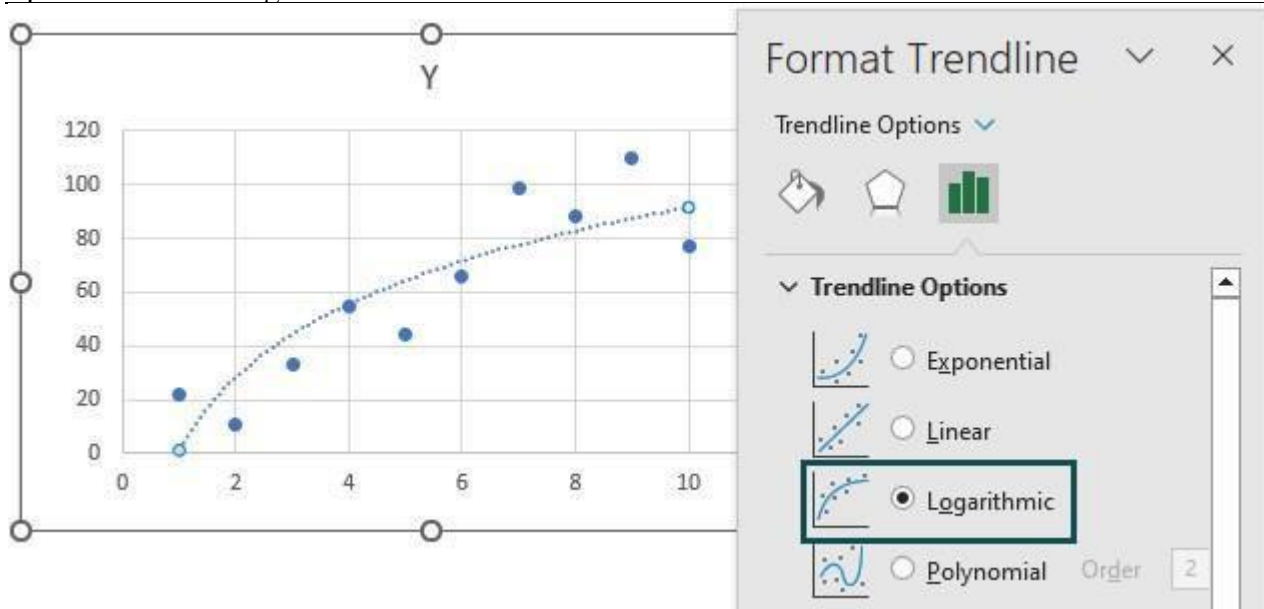
We see the trendline is linear. But the data points do not align with the linear trendline. It implies that the relationship between X and Y is nonlinear.

Next, we shall find the trendline that best fits our model.

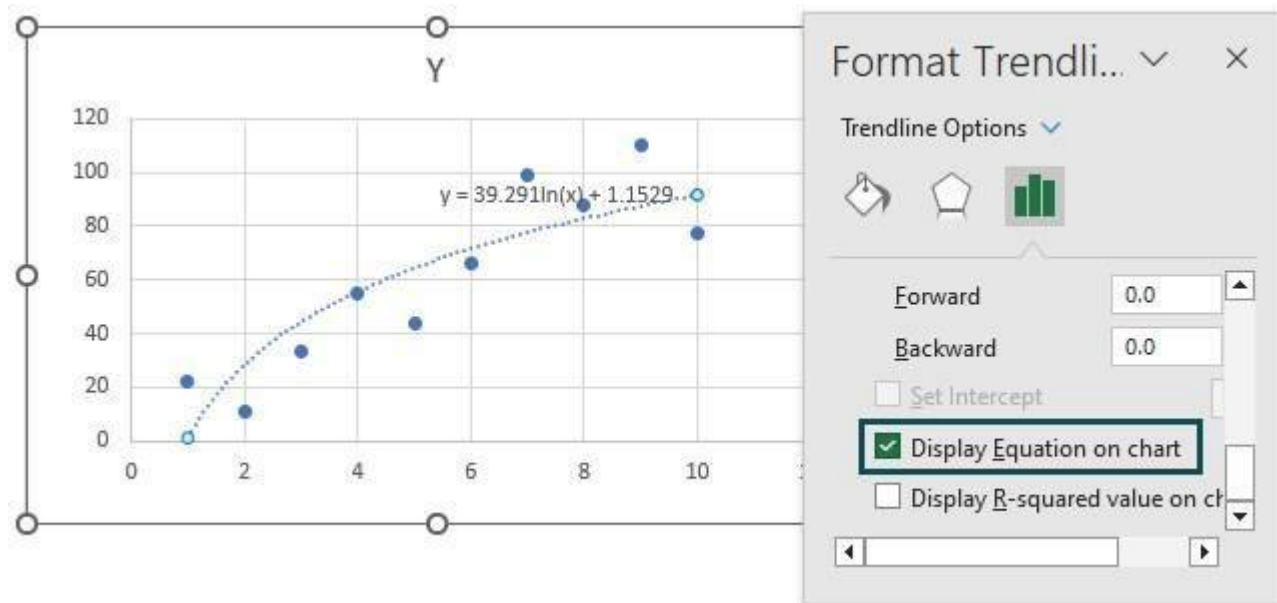
Step 3: Then, click the **Chart Elements** option and uncheck the **Trendline** box. And click the **Trendline** right arrow to choose **More Options** from the list.



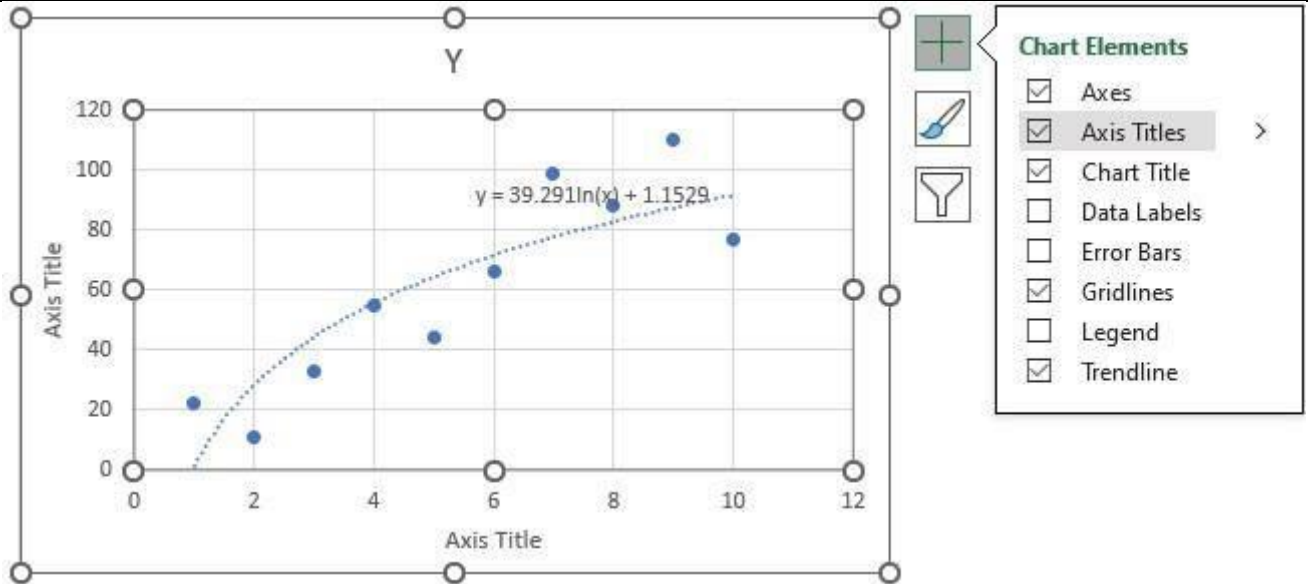
Step 4: The **Format Trendline** window opens, where we must try every option to determine the appropriate trendline. In this case, the **Logarithmic** curve best fits our model to the data.



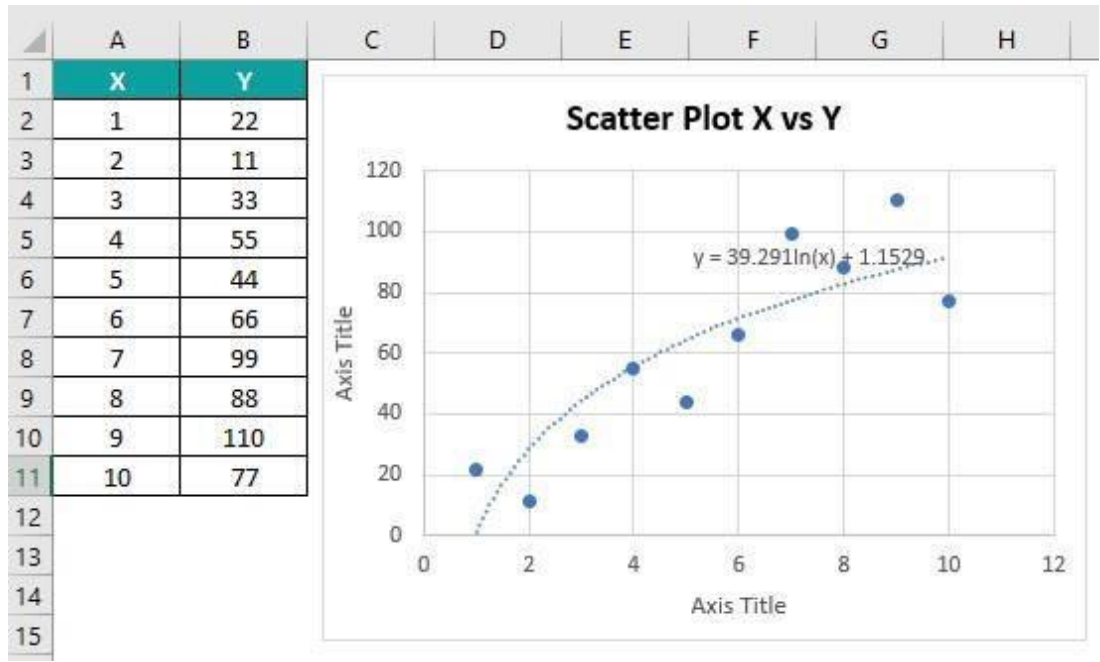
Next, scroll down the **Format Trendline** pane and check the option to display the **Excel nonlinear regression formula** or equation in the chart area.



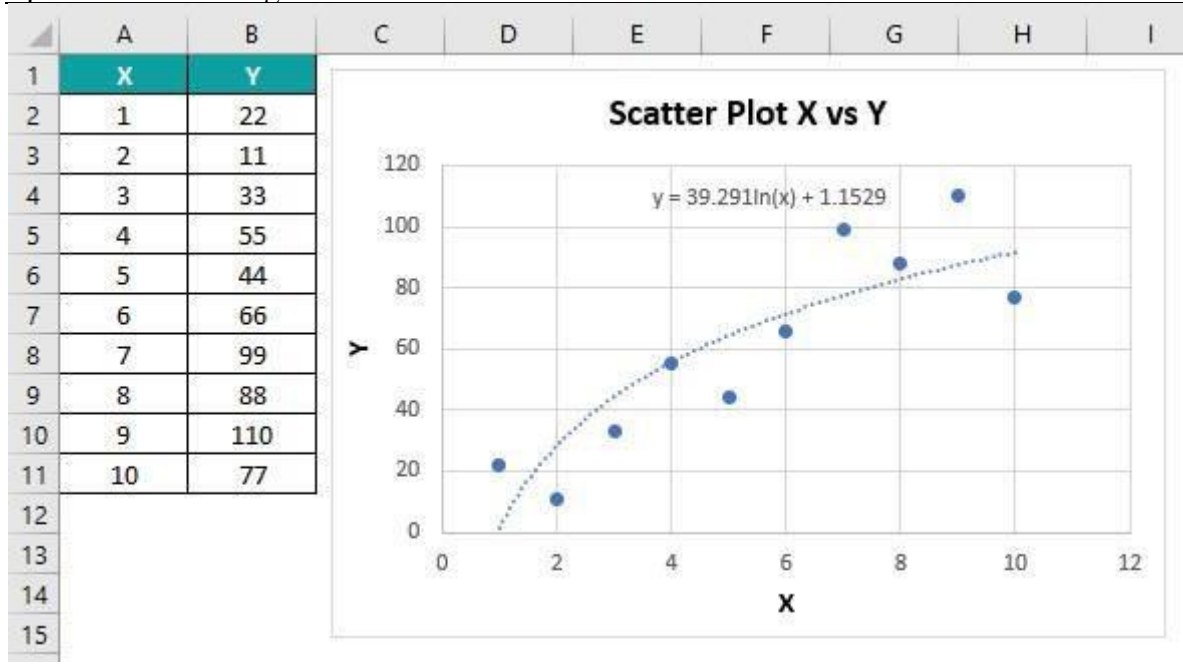
Step 5: Now, click the **Chart Elements** option and check the **Axis Titles** option.



Step 6: Next, double-click the chart title and axis titles' elements in the chart area, one at a time. And update them, as shown below.



Thus, the final Scatter plot gives the non-linear regression in Excel for the given data will be depicted below.



Examples

Check out the following non-linear regression in Excel examples to use it effectively.

Example #1

The table below contains the trial results of an experiment involving one independent and one dependent parameter.

	A	B	C
1	Trial	Independent Parameter	Dependent Parameter
2	T_1	11	10.7
3	T_2	12	9.6
4	T_3	13	9
5	T_4	14	8.2
6	T_5	15	7.5
7	T_6	16	7
8	T_7	17	6.5
9	T_8	18	6.1
10	T_9	19	5.7
11	T_10	20	5.4
12			

Suppose the requirement is to determine the non-linear regression in Excel for the above data. Then, the steps are as follows:

Step 1: First, select the cell range B1:C11 and then, follow the path **Insert – Scatter (X, Y) or Bubble Chart – Scatter** chart.

	A	B	C
	Trial	Independent Parameter	Dependent Parameter
1			
2	T_1	11	10.7
3	T_2	12	9.6
4	T_3	13	9
5	T_4	14	8.2
6	T_5	15	7.5
7	T_6	16	7
8	T_7	17	6.5
9	T_8	18	6.1
10	T_9	19	5.7
11	T_10	20	5.4
12			

Step 2: Next, click **Chart Elements – Trendline** right arrow – **More Options** to open the **Format Trendline** window.

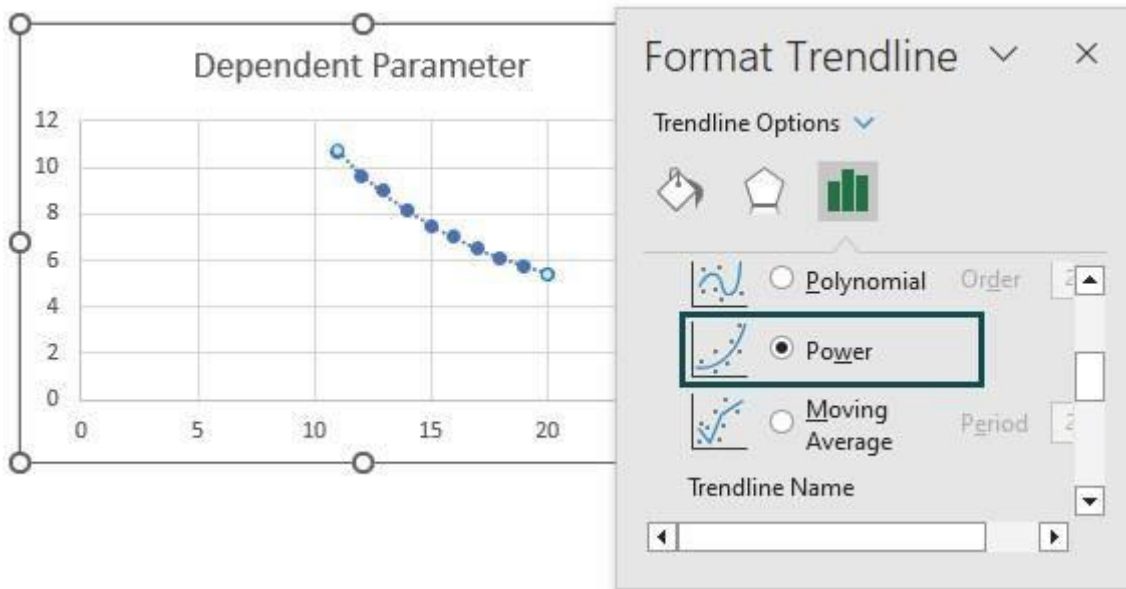
Chart Elements

- Axes
- Axis Titles
- Chart Title
- Data Labels
- Error Bars
- Gridlines
- Legend
- Trendline

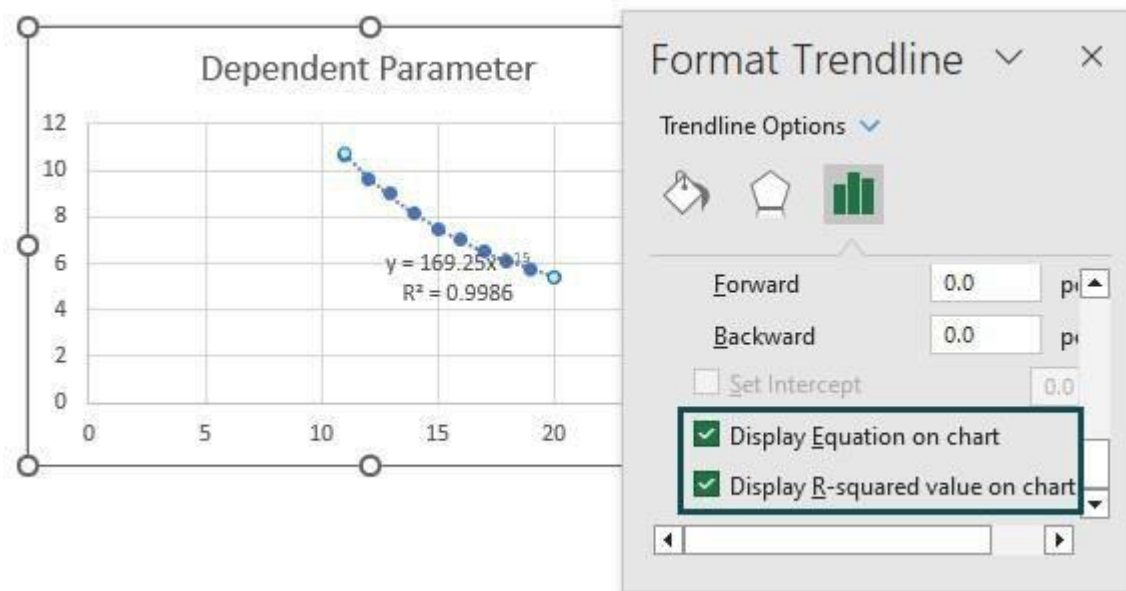
Trendline Options

- Linear
- Exponential
- Linear Forecast
- Two Period Moving Average
- More Options...**

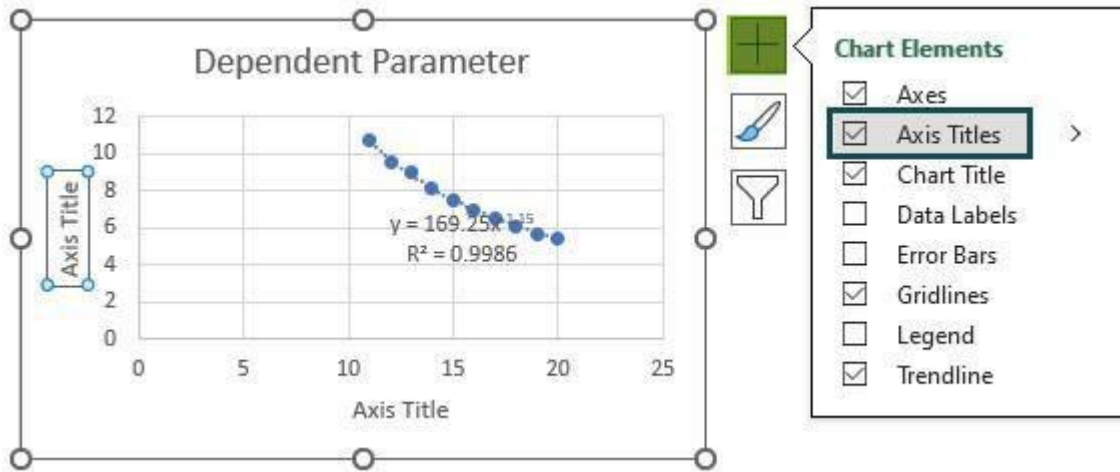
Step 3: Then, pick the **Power** curve under the **Trendline Options**, as it helps to fit the model to the given data in the best way possible.



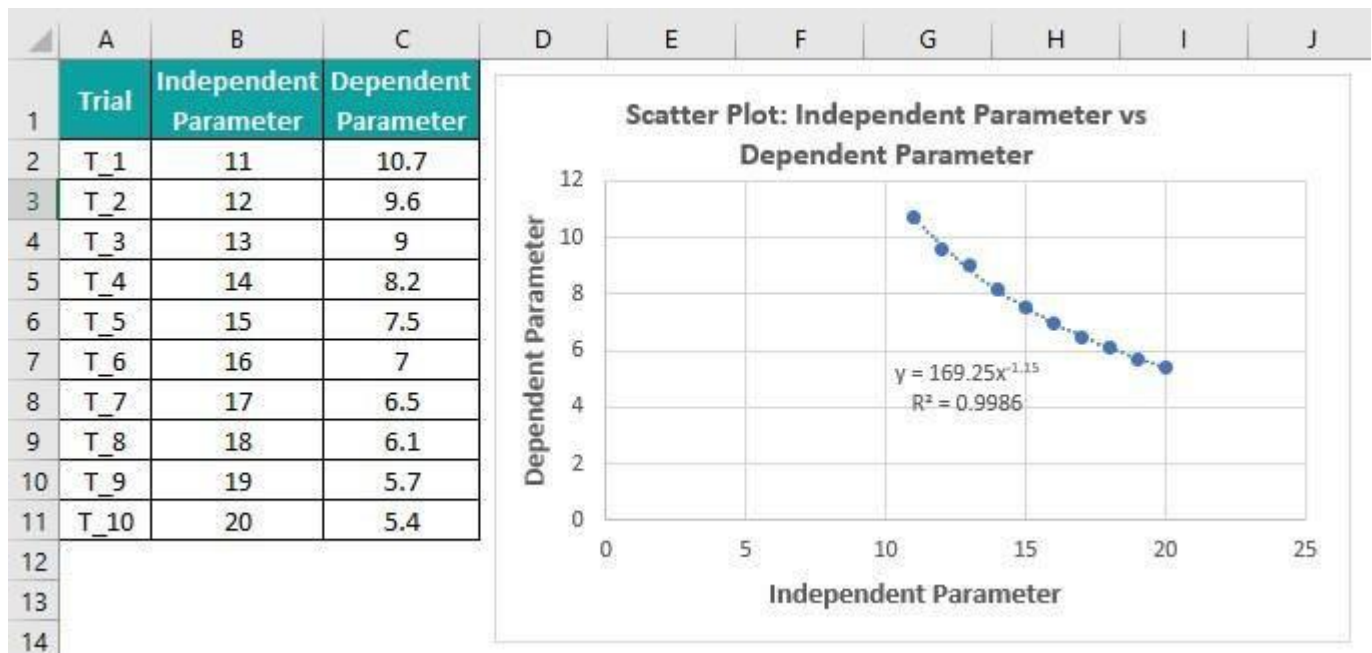
Step 4: Now, check the options to display the nonlinear regression equation and the R-squared value in the chart area.



Step 5: Next, click **Chart Elements – Axis Titles**.



Finally, double-click the chart and axis titles elements, one at a time, to update them in the chart area.



The R-squared value of **0.999** indicates that the model best fits the given data. And we can use the power equation for nonlinear regression analysis, with x in the expression representing the independent parameter and y , the dependent parameter.

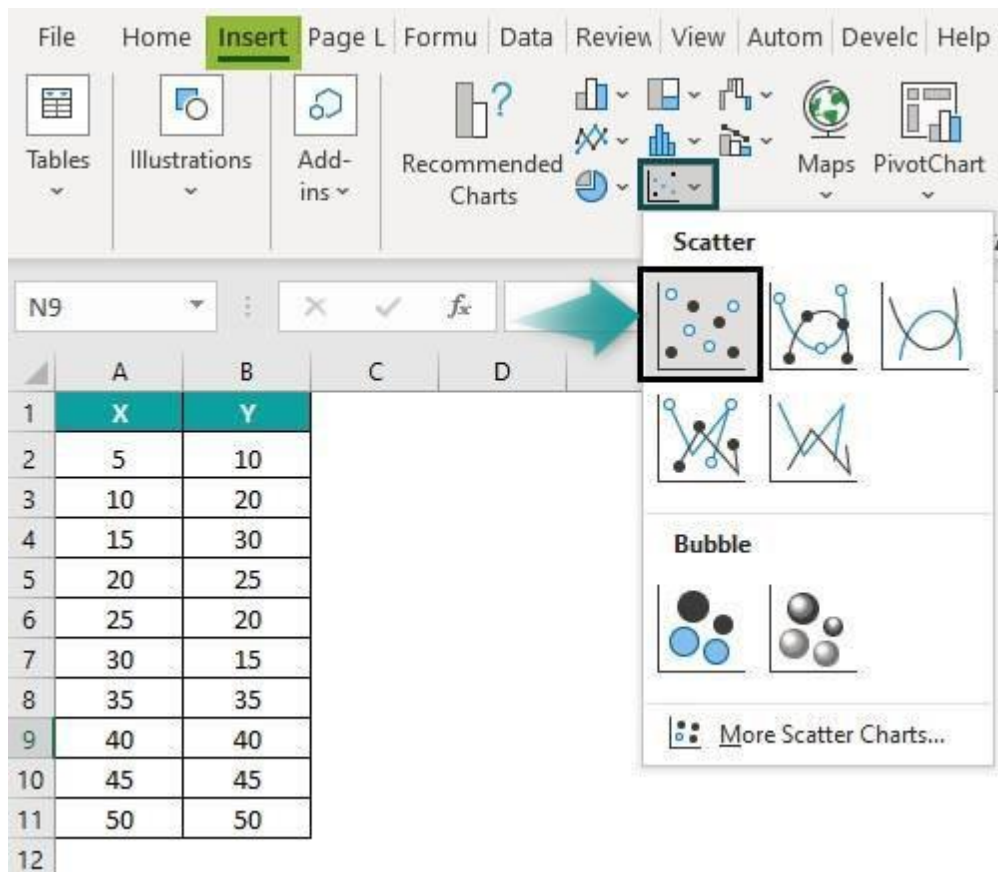
Example #2

The table below contains a list of **X** and **Y** values.

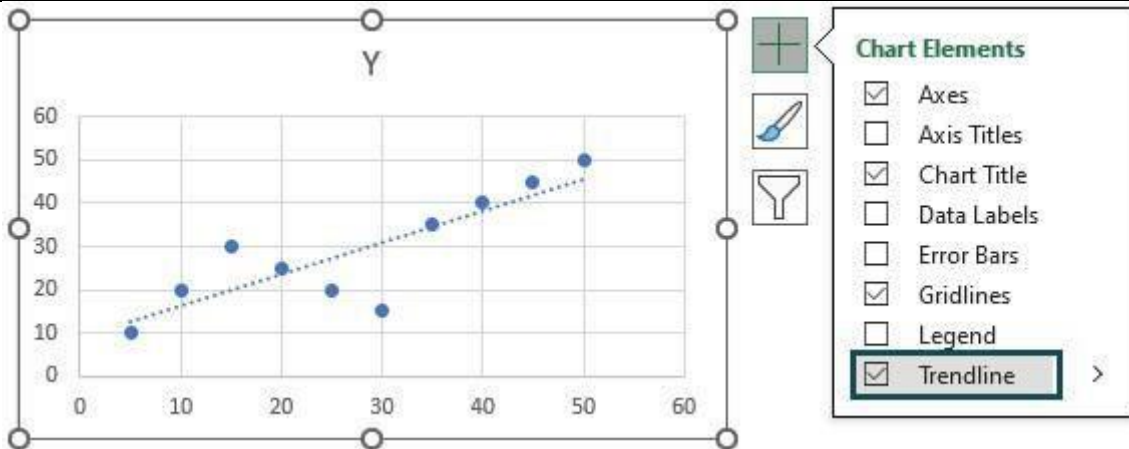
	A	B
1	X	Y
2	5	10
3	10	20
4	15	30
5	20	25
6	25	20
7	30	15
8	35	35
9	40	40
10	45	45
11	50	50
12		

Suppose we must evaluate the non-linear regression in Excel for the above data. Then, the steps are as follows:

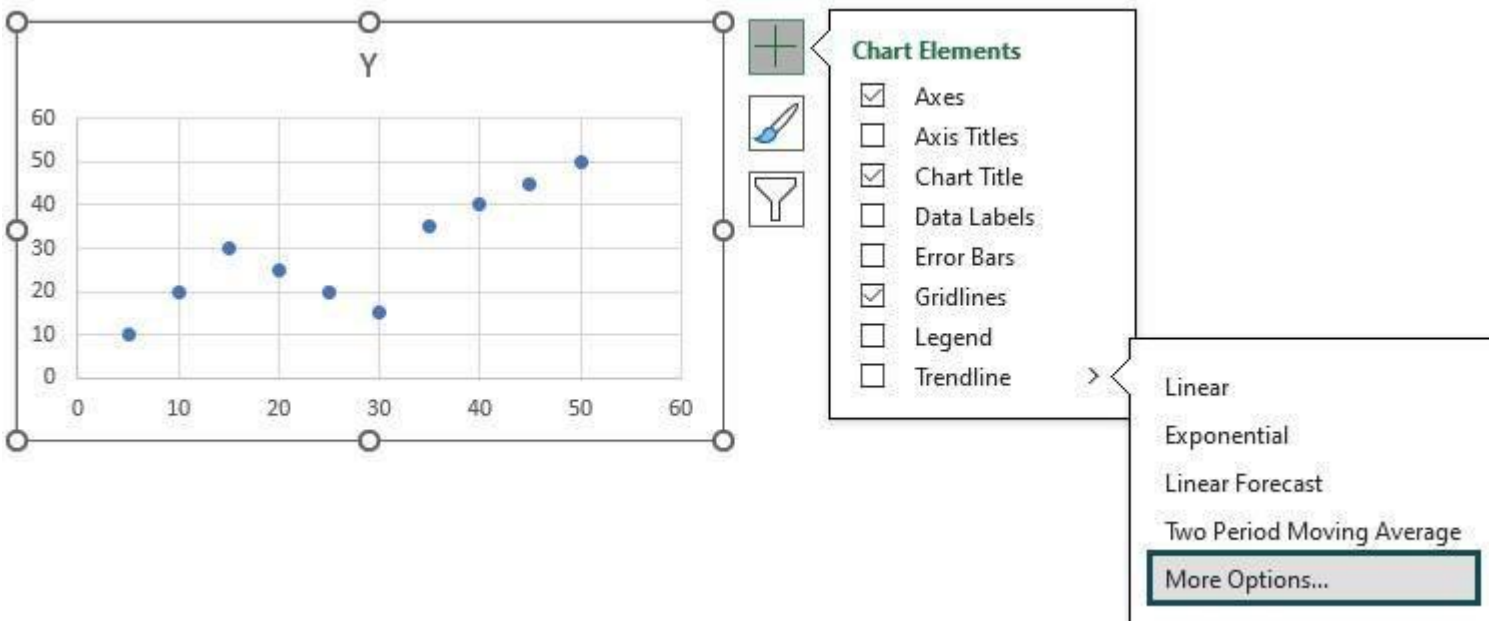
Step 1: First, click on a cell in the given table, and then, follow the path **Insert – Scatter (X, Y) or Bubble Chart – Scatter** chart to visualize the given data in a chart format.



And clicking **Chart Elements – Trendline** shows a linear line, which indicates that the relationship between the two parameters is nonlinear.

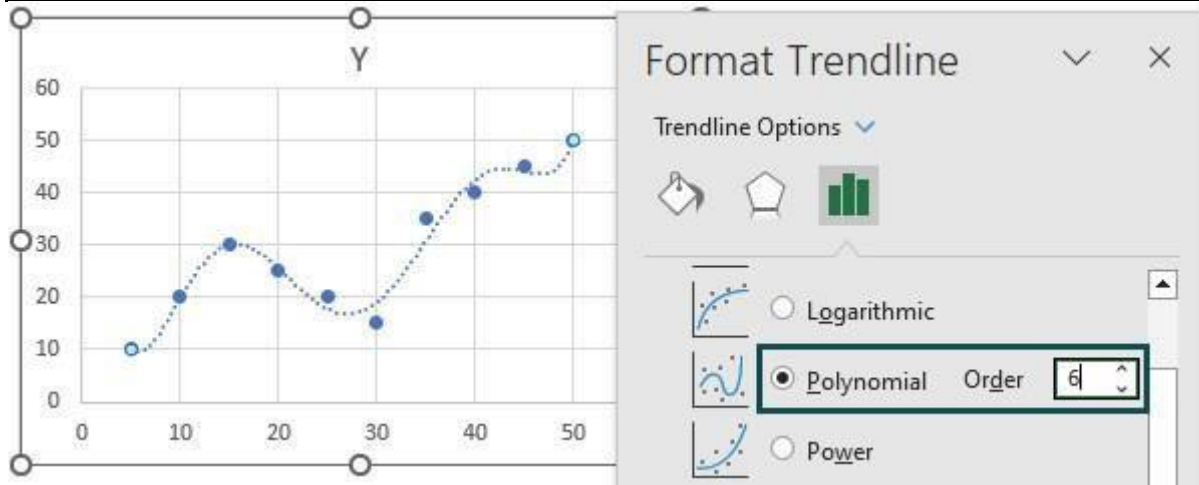


Step 2: Next, uncheck the **Trendline** option and then, click the **Trendline** right arrow to pick **More Options**.

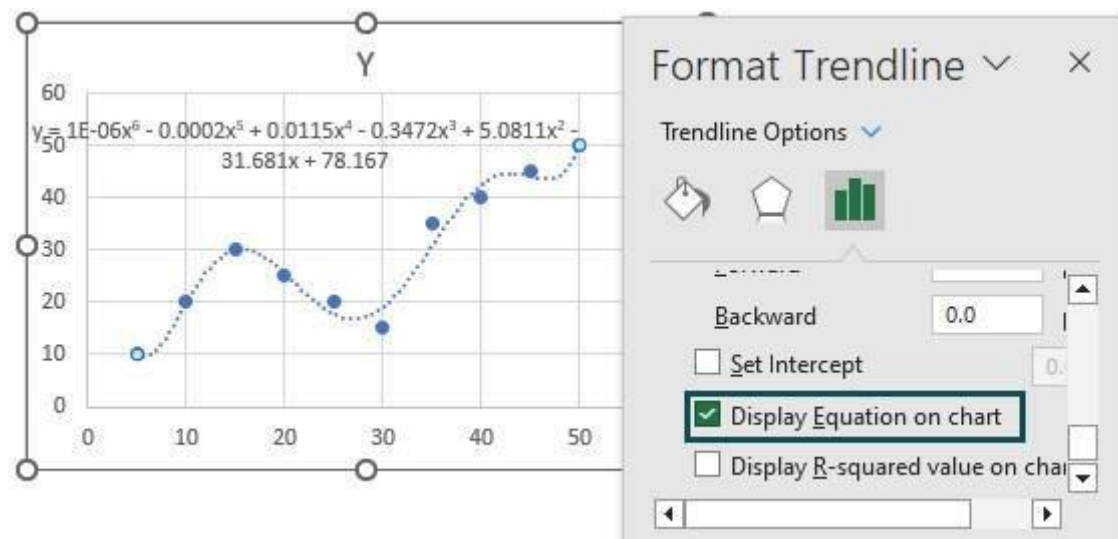


The **Format Trendline** window will open, where we must check every trendline option to identify the best curve fitting the given data into a model.

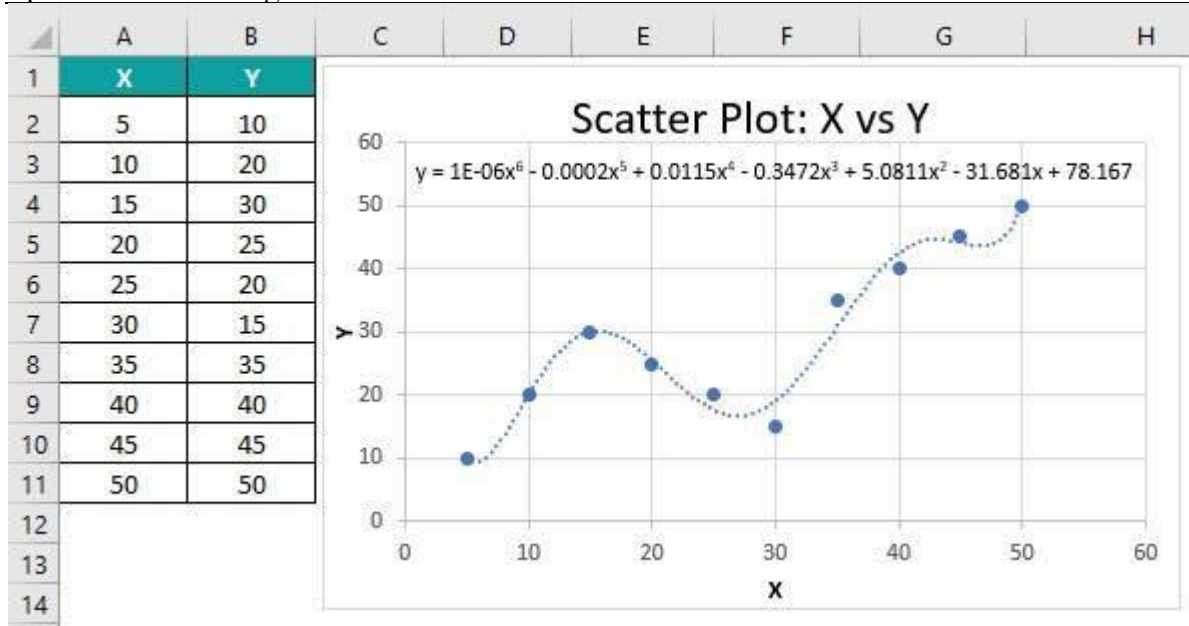
In this example, we find the best fit with the **Polynomial** curve with the **Order** set as **6**. We can click the drop-down buttons to increase and decrease the order, as per our requirement.



And check the option to display the nonlinear regression equation.



Step 3: Next, update the chart and axis titles as explained in the previous section to obtain the below Scatter plot for non-linear regression in Excel for the given X and Y values.



We shall now see how to use the [excel function LINEST](#) for nonlinear regression in Excel. The function will help us determine the variable coefficients in the nonlinear regression equation.

Sometimes, displaying the nonlinear regression equation from the **Format Trendline** window shows the coefficients up to one or two significant digits. It limits the analysis accuracy to the same number of significant digits.

Also, we may require to show the equation in the worksheet. And in such a case, when we update the source data, the equation does not get updated.

But when using the function **LINEST for nonlinear regression in Excel**, the coefficient accuracy will be for more significant digits. And when we update the source data, the coefficients also get updated automatically, as the function works with the given datasets.

Step 4: Now, we shall introduce a table to determine the nonlinear regression equation coefficients using the **LINEST()**.

	J	K	L	M	N	O	P	Q
1	LINEST()- For Determining Polynomial Equation Coefficients							
2	Term	x^6	x^5	x^4	x^3	x^2	x	c (Constant)
3	Coefficient							
4								
5								

Step 5: Next, select the cell range K3:Q3.

	J	K	L	M	N	O	P	Q
1	LINEST()- For Determining Polynomial Equation Coefficients							
2	Term	x^6	x^5	x^4	x^3	x^2	x	c (Constant)
3	Coefficient							
4								
5								

And enter the **LINEST()**.

=LINEST((B2:B11),(A2:A11)^(1,2,3,4,5,6),TRUE,FALSE)

LINEST		=LINEST((B2:B11),(A2:A11)^(1,2,3,4,5,6),TRUE,FALSE)							
		X	✓	fx					
	J	K	L	M	N	O	P	Q	R
1	LINEST()- For Determining Polynomial Equation Coefficients								
2	Term	x^6	x^5	x^4	x^3	x^2	x	c (Constant)	
3	Coefficient	=LINEST((B2:B11),(A2:A11)^(1,2,3,4,5,6),TRUE,FALSE)							
4									

Next, press **Ctrl + Shift + Enter** to apply the expression as an [array formula in excel](#).

K3		={=LINEST((B2:B11),(A2:A11)^(1,2,3,4,5,6),TRUE,FALSE)}							
		X	✓	fx					
	J	K	L	M	N	O	P	Q	R
1	LINEST()- For Determining Polynomial Equation Coefficients								
2	Term	x^6	x^5	x^4	x^3	x^2	x	c (Constant)	
3	Coefficient	1.0889E-06	-0.00018	0.01146	-0.3472	5.08111	-31.681	78.1666667	
4									

The **LINEST()** determines a line's statistics using the least squares technique to obtain a line that fits the given data in the best way possible. And it returns an array of values describing the line.

The function accepts the known **Y** value range and the known **X** value range to the power of array **{1,2,3,4,5,6}** as we require six coefficients. And it takes two logical values to calculate the constant **c** normally and return the coefficients and constant **c**, respectively.

Further, we select seven cells to display the resulting array containing six coefficients and a constant.

So, thus we obtain the required coefficients for our nonlinear regression equation, matching those obtained using the option in the **Format Trendline** window.

Example #3

The non-linear regression in Excel works when the number of dependent variables is one. However, the source data can have more than one independent variable.

For example, in the table below, **Z** is the dependent variable. And **1/X** and **Y** are the independent variables.

Spread Sheet for Engineers

	A	B	C	D	E
1	X		Z	1/X	Y
2	2		200		8
3	4		330		16
4	6		450		24
5	8		500		32
6	10		640		40
7	12		710		48
8	14		830		56
9					

Using the column A values, we must determine $1/X$ values in column D. And determine the non-linear regression in Excel for the given variables **Z**, $1/X$, and **Y**.

Then, the steps are as follows:

Step 1: To begin with, select cell D2, enter the formula, and then, press **Enter**.

$=1/A2$



And using the [fill handle in excel](#), enter the formula in cell range D3:D8.

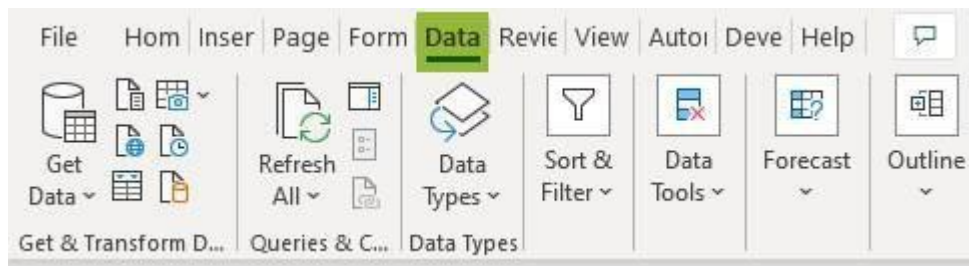
Spread Sheet for Engineers

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E
1	X		Z	1/X	Y
2	2		200	0.5	8
3	4		330	0.25	16
4	6		450	0.166667	24
5	8		500	0.125	32
6	10		640	0.1	40
7	12		710	0.083333	48
8	14		830	0.071429	56
9					

Next, we will use the **Regression** analysis tool from the [Data Analysis ToolPak](#) feature in the **Data** tab to obtain the nonlinear regression equation required for the analysis.

Suppose the **Data** tab does not show the **Data Analysis** option, as depicted below:

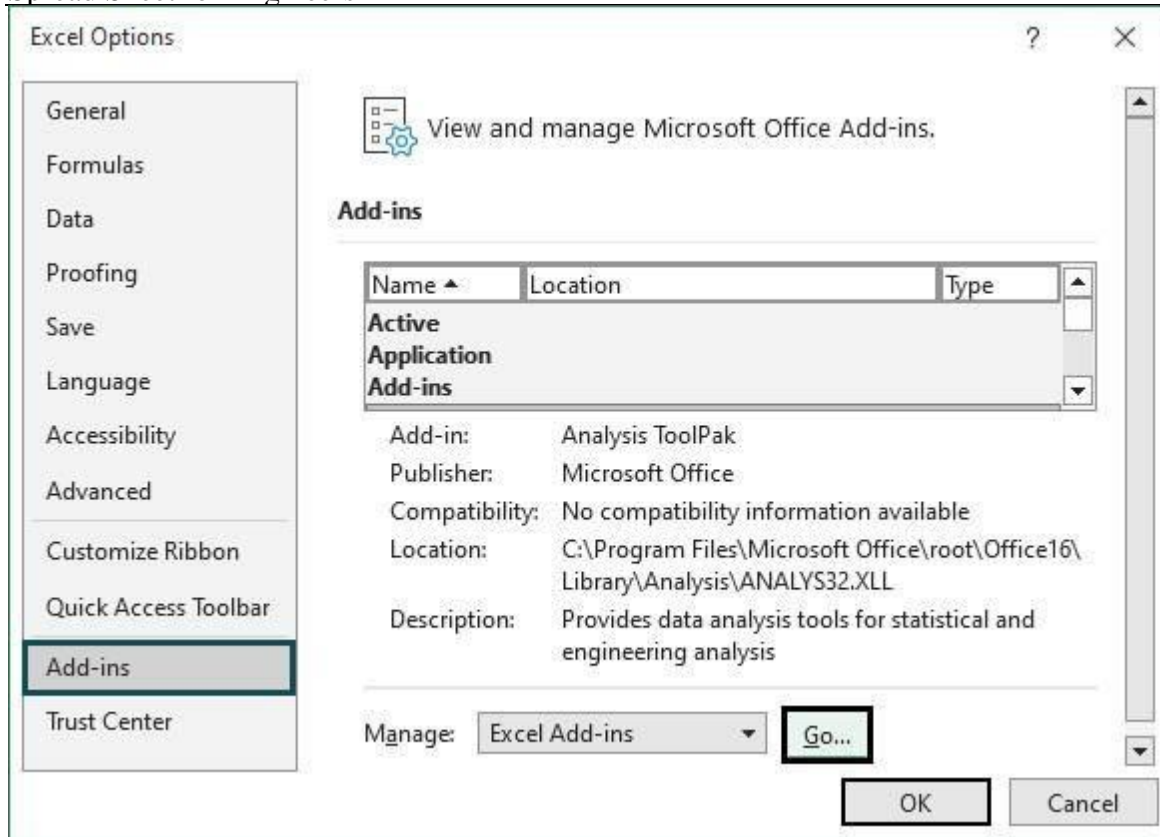


Then, here are the steps to enable the option in the **Data** tab.

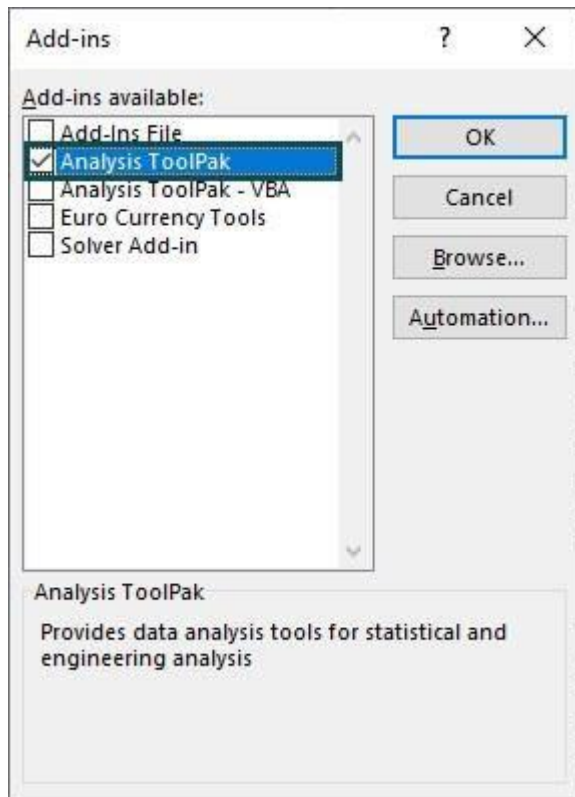
Step 2: Next, click **File – Options** to open the **Excel Options** tab.



Then, choose **Add-ins** in the menu and then, click **Go** in the **Excel Options** window.

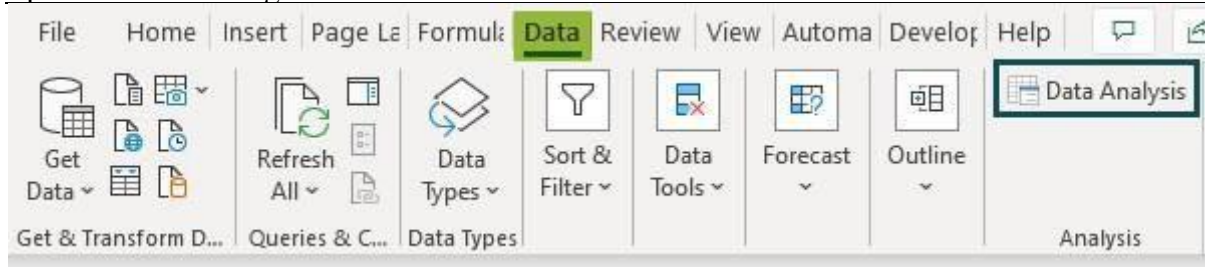


Now, the **Add-ins** window will open, where we must check the **Analysis ToolPak** box and click **OK**.



We can now see the **Data Analysis** option from the **Data** tab.

Spread Sheet for Engineers

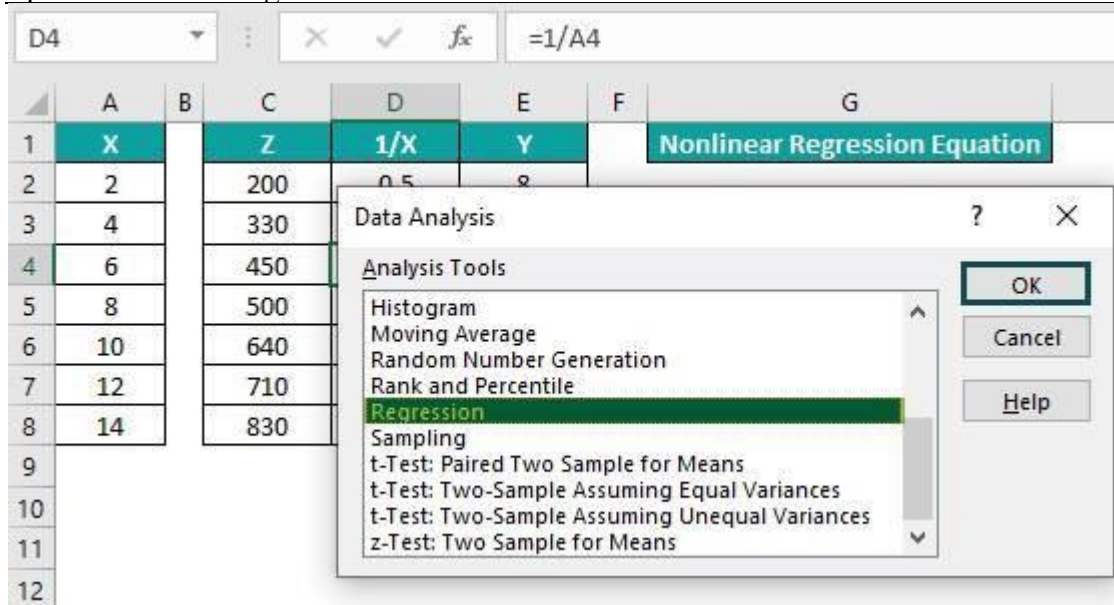


Step 3: Next, click on a cell in the table range C1:E8 and then, follow the path **Data – Data Analysis** to open the **Data Analysis** window.

The screenshot shows the Microsoft Excel ribbon with the 'Data' tab selected. The 'Data Analysis' button is highlighted with a red box. A blue arrow points to the 'Data Analysis' button. Below the ribbon, the formula bar shows '=1/A4' and the spreadsheet grid shows a table with columns X, Z, 1/X, and Y.

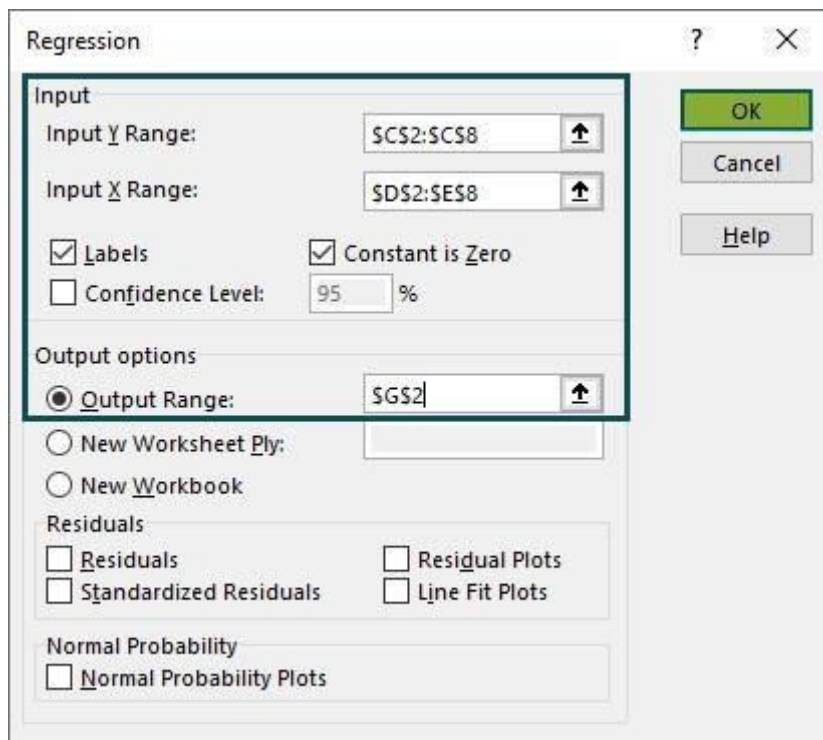
	A	B	C	D	E	F	G	H
1	X		Z	1/X	Y		Nonlinear Regression Equation	
2	2		200	0.5	8			
3	4		330	0.25	16			
4	6		450	0.166667	24			
5	8		500	0.125	32			
6	10		640	0.1	40			
7	12		710	0.083333	48			
8	14		830	0.071429	56			
9								

Next, pick **Regression** from the **Analysis Tools** list in the **Data Analysis** window, and click **OK**.



Step 4: The **Regression** window opens. Update the **Z** variable dataset as the input **Y** range and the **1/X** and **Y** variables' data ranges as the input **X** range.

Include the column headings in the input ranges and check the **Labels** box to view the variable names in the output. Also, we shall assume the constant is 0 and let the confidence level be 95%, implying the significance threshold is **0.05**.



And let us pick the first option under **Output options** and set the range as cell G2 to view the summary in cell G2 of the current worksheet.

Finally, click **OK** to obtain the below summary output.

Spread Sheet for Engineers

	G	H	I	J	K	L	M	N	O	
1	Nonlinear Regression Equation									
2	SUMMARY OUTPUT									
3										
4	<i>Regression Statistics</i>									
5	Multiple R	0.99846808								
6	R Square	0.996938507								
7	Adjusted R Square	0.796326209								
8	Standard Error	36.73562315								
9	Observations	7								
10										
11	ANOVA									
12		<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>				
13	Regression	2	2197252.47	1098626.235	814.0951046	6.0059E-06				
14	Residual	5	6747.530042	1349.506008						
15	Total	7	2204000							
16										
17		<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>	
18	Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
19	1/X	225.3487589	68.16356116	3.306000377	0.021334097	50.12874673	400.5687711	50.12874673	400.5687711	
20	Y	14.90292799	0.442705603	33.66329202	4.34934E-07	13.764917	16.04093897	13.764917	16.04093897	
21										

The **R Square** value is **0.996938507**. It indicates that the model fits the data well.

Also, the **P-value** of the two independent variables, **1/X** and **Y**, is below **0.05**, the significance threshold, indicating the model is significant.

Spread Sheet for Engineers

	G	H	I	J	K	L	M	N	O
1	Nonlinear Regression Equation								
2	SUMMARY OUTPUT								
3									
4	<i>Regression Statistics</i>								
5	Multiple R	0.998468							
6	R Square	0.996939							
7	Adjusted R Square	0.796326							
8	Standard Error	36.73562							
9	Observations	7							
10									
11	ANOVA								
12		<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
13	Regression	2	2197252.47	1098626.23	814.0951046	6.0059E-06			
14	Residual	5	6747.530042	1349.50601					
15	Total	7	2204000						
16									
17		<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
18	Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
19	1/X	225.3488	68.16356116	3.30600038	0.021334097	50.1287467	400.568771	50.1287467	400.568
20	Y	14.90293	0.442705603	33.663292	4.34934E-07	13.764917	16.040939	13.764917	16.040
21									

Thus, we can use the coefficients of the two independent variables, 1/X and Y, to form the required nonlinear regression equation in cell H1.

	G	H	I	J	K	L	M	N	O
1	Nonlinear Regression Equation	$z = 225.3487589/x + 14.90292799y$							
2	SUMMARY OUTPUT								
3									
4	<i>Regression Statistics</i>								
5	Multiple R	0.99847							
6	R Square	0.99694							
7	Adjusted R Square	0.79633							
8	Standard Error	36.7356							
9	Observations	7							
10									
11	ANOVA								
12		<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
13	Regression	2	2197252.47	1098626.23	814.095105	6.0059E-06			
14	Residual	5	6747.530042	1349.50601					
15	Total	7	2204000						
16									
17		<i>Coefficient</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
18	Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
19	1/X	225.349	68.16356116	3.30600038	0.0213341	50.12874673	400.568771	50.1287467	400.568771
20	Y	14.9029	0.442705603	33.663292	4.3493E-07	13.764917	16.040939	13.764917	16.040939
21									

Important Things To Note

- The trendline will not be linear when calculating the non-linear regression in Excel. Thus, ensure to pick the trendline curve from the **Format Trendline** window that best fits the model to the data.
- The R-squared value does not count in nonlinear regression. But we can use it to pick the suitable trendline curve from the options in the **Format Trendline** window, with a higher value indicating the model fits the data better.
- When using the **Regression Analysis ToolPak** to calculate nonlinear regression, ensure the independent variables' P-value is below the significance threshold. It indicates the model is significant, and we can use the independent variables' coefficients to create the nonlinear regression equation.

Frequently Asked Questions

1. Can Excel do non-linear regression?

Excel can do non-linear regression. It calculates the nonlinear least square regression to determine the nonlinear relationship between response and predictors.

2. What is linear vs non-linear in Excel?

Linear vs. non-linear in Excel is one of the two ways of performing regression analysis.

Linear regression creates a straight line that graphically represents the linear relation between the dependent and independent parameters.

On the other hand, non-linear regression creates a curve, graphically representing the nonlinear relationship between the dependent and independent variables.

3. How do you find the non linear line of best fit in Excel?

We can find the non linear line of best fit in Excel using the **Trendline Options** in the **Format Trendline** window. Let us see the steps with an example.

The following table contains the average annual rainfall data from 2011-20.

	A	B
1	Year	Average Annual Rainfall (inches)
2	2011	32.22
3	2012	33.19
4	2013	33.48
5	2014	33.26
6	2015	33.57
7	2016	34.11
8	2017	34.17
9	2018	34.65
10	2019	32.93
11	2020	31.42
12		

Here is how to find the non-linear line of best fit in Excel for the above data.

Step 1: First, click on a cell in the table and then, follow the path **Insert – Scatter (X, Y) or Bubble Chart – Scatter** chart.

	A	B
1	Year	Average Annual Rainfall (inches)
2	2011	32.22
3	2012	33.19
4	2013	33.48
5	2014	33.26
6	2015	33.57
7	2016	34.11
8	2017	34.17
9	2018	34.65
10	2019	32.93
11	2020	31.42
12		

Step 2: Next, click **Chart Elements – Trendline** right arrow – **More Options** to open the **Format Trendline** window.

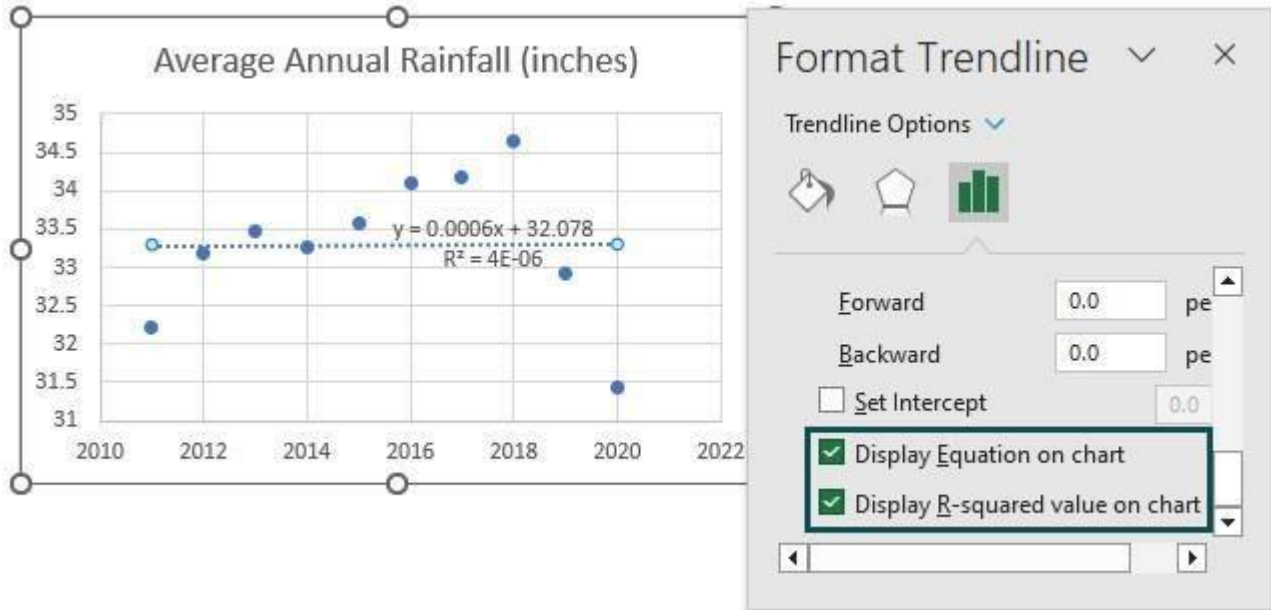
Chart Elements

- Axes
- Axis Titles
- Chart Title
- Data Labels
- Error Bars
- Gridlines
- Legend
- Trendline

Trendline Options:

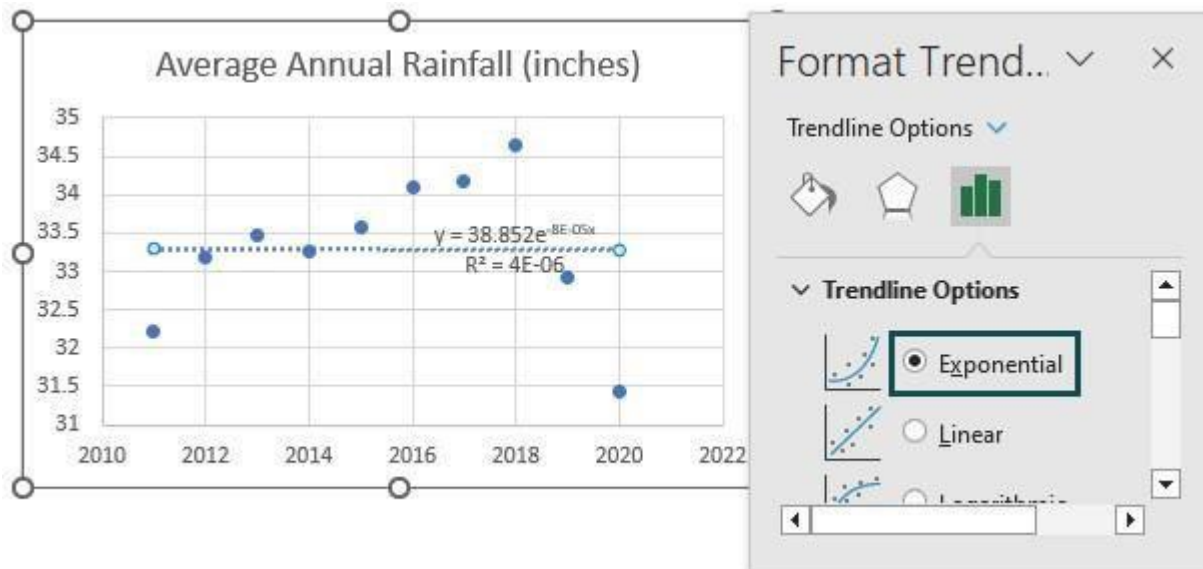
- Linear
- Exponential
- Linear Forecast
- Two Period Moving Average
- More Options...**

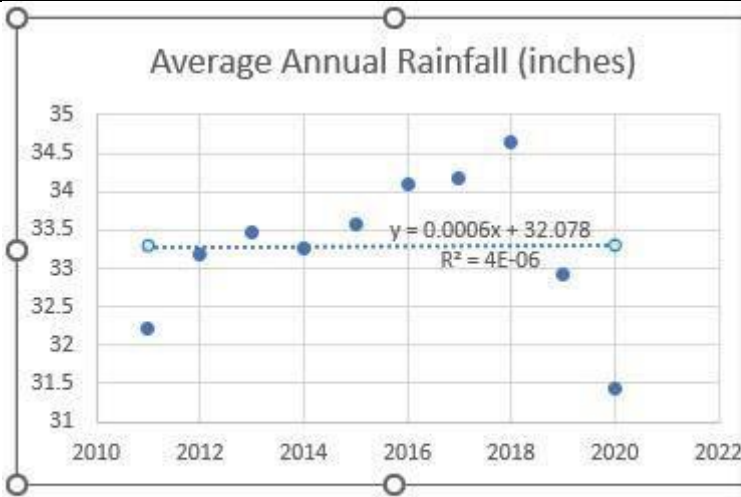
The linear trendline will appear by default as the best-fit line. Next, scroll down the **Format Trendline** window to select the options to display the line equation and R-value.



We now must check the trendline curve that best fits the model to the data. And for that, we can select one Trendline curve at a time and check the R-squared value. The one with the highest R-squared value will be the best-fitting curve.

Step 3: Next, pick each curve one by one under **Trendline Options** and then, check the respective R-squared value.

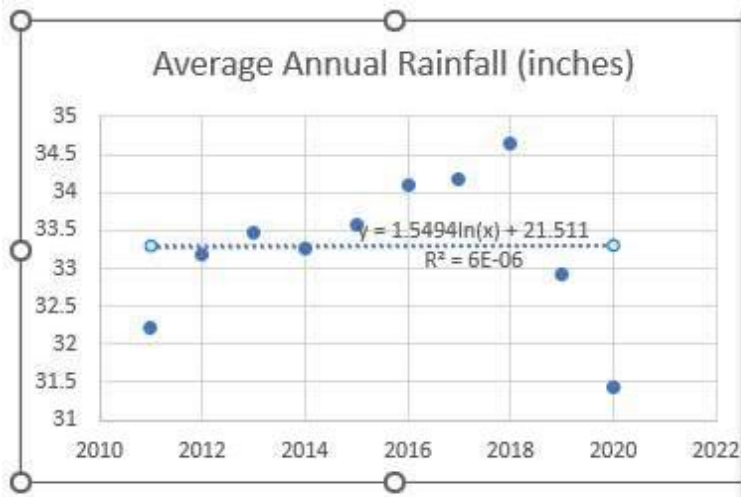




Format Trendline

Trendline Options

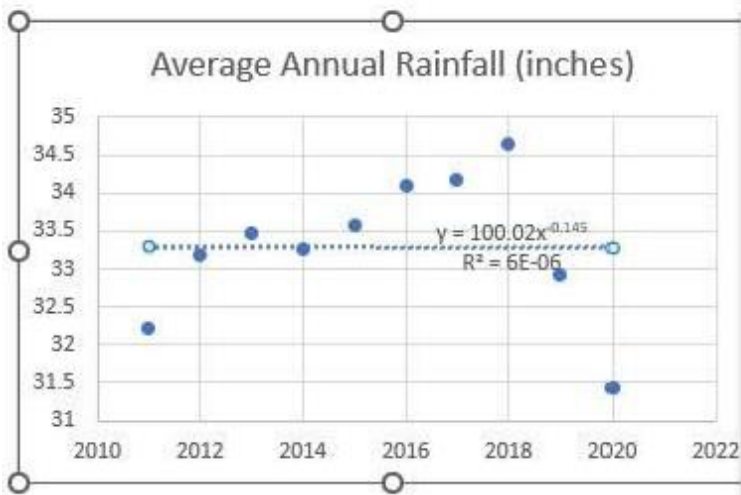
- Exponential
- Linear
- Polynomial
- Moving Average



Format Trendline

Trendline Options

- Linear
- Logarithmic
- Polynomial
- Moving Average



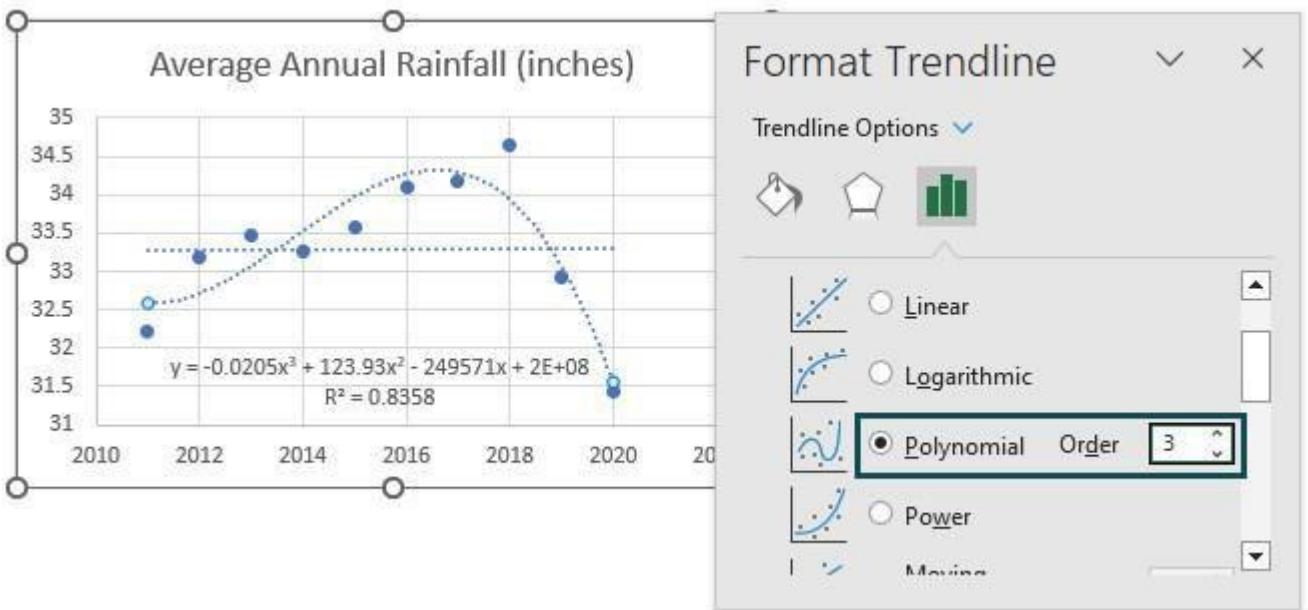
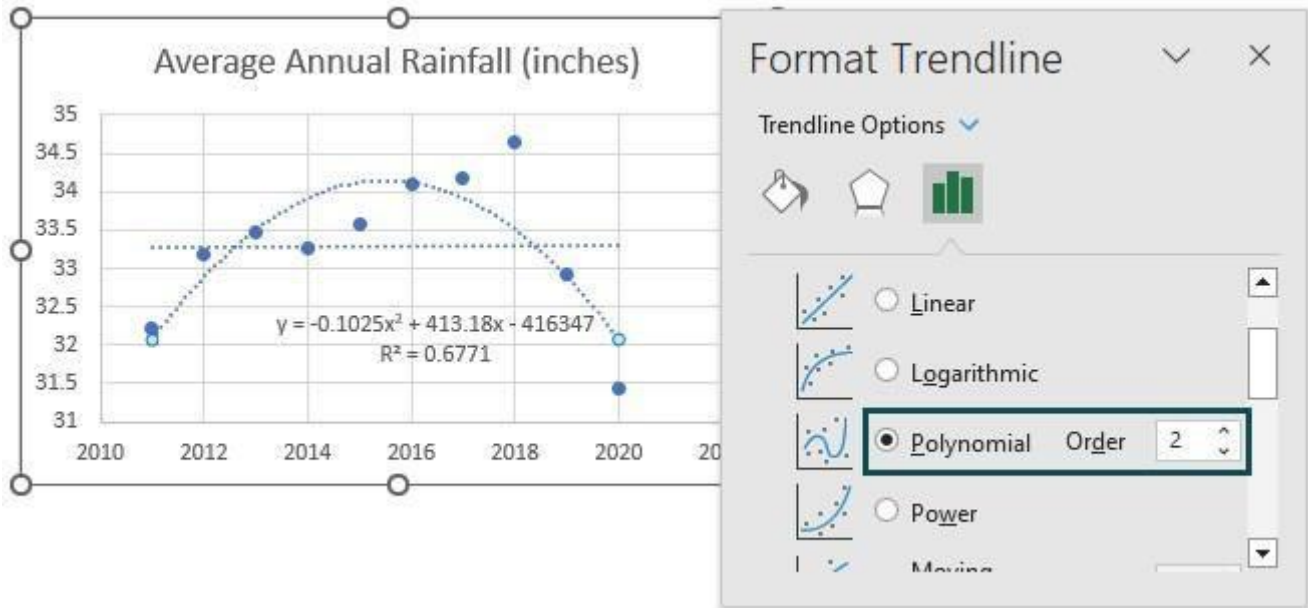
Format Trendline

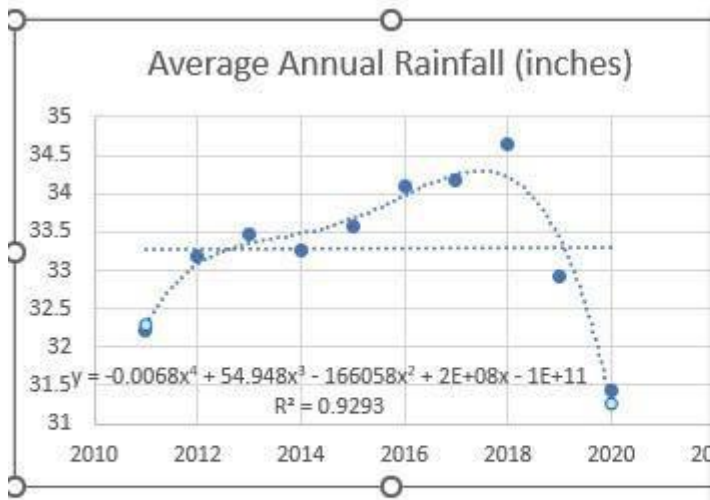
Trendline Options

- Logarithmic
- Polynomial
- Power
- Moving Average

For all the above-chosen options, the R-squared values are low.

Hence, we shall now check the **Polynomial** curve and change the **Order** one step at a time using the drop-down buttons to look for the curve with the highest R-squared value.

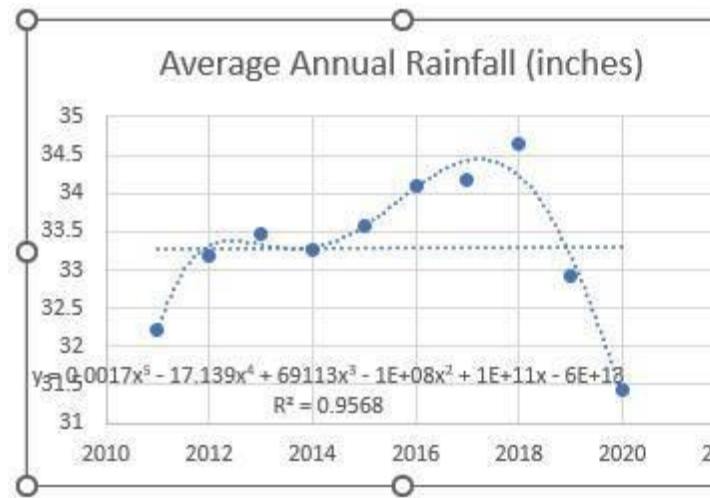




Format Trendline

Trendline Options

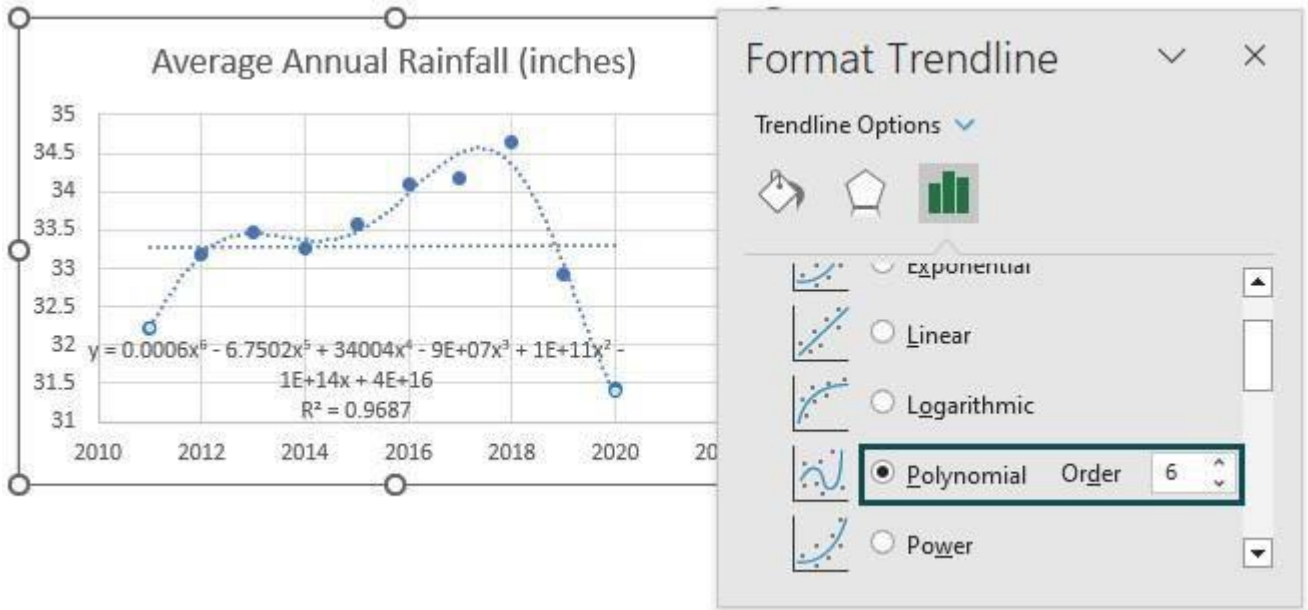
- Linear
- Logarithmic
- Polynomial Order 4
- Power



Format Trendline

Trendline Options

- Linear
- Logarithmic
- Polynomial Order 5
- Power

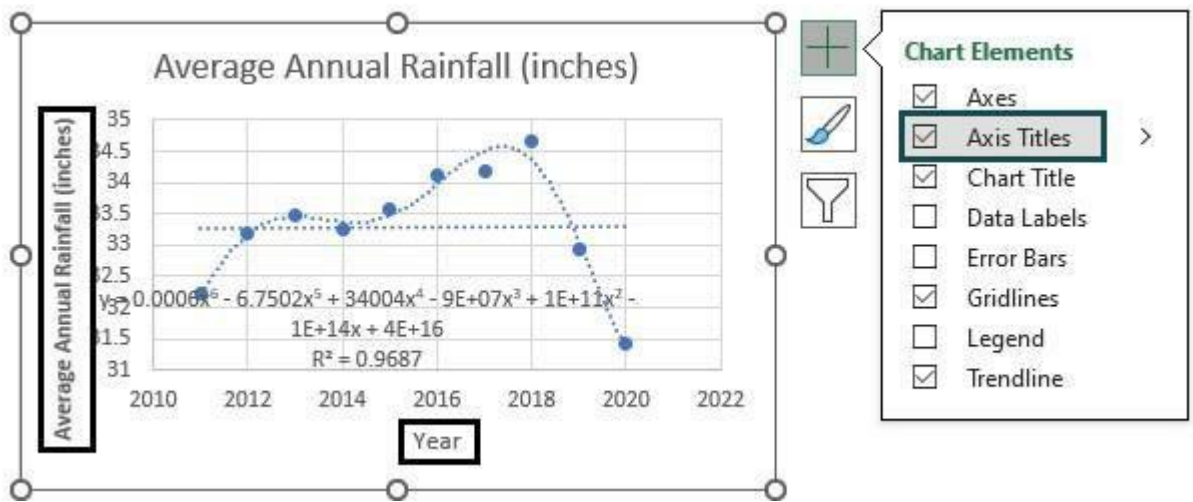


The **Order** of 6 is the maximum value that Excel offers. And in this example, the **Polynomial** curve with **Order** 6 shows the highest R-squared value, **0.9687** or **96.87%**.

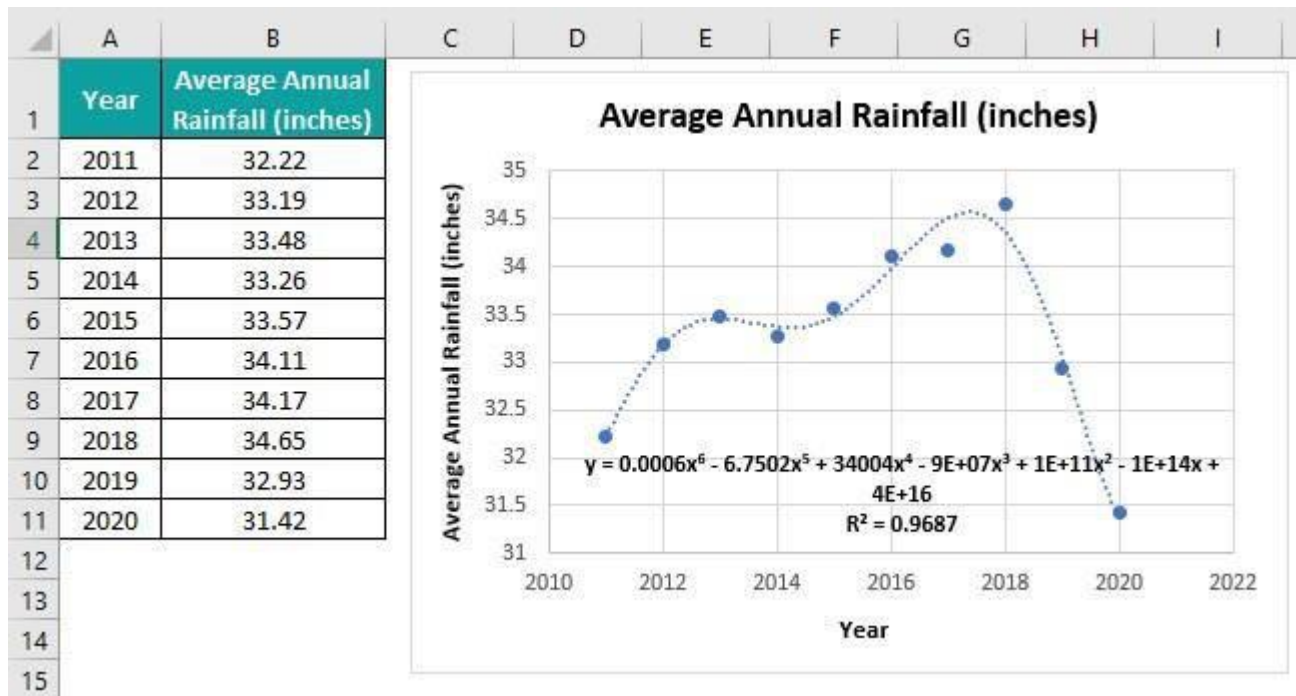
Thus, the non-linear line of best fit for the given data is the Polynomial curve of order 6.

Step 4: Then, click **Chart Elements – Axis Titles**.

Next, double-click the chart and axis titles elements one at a time to update them as depicted below:



Step 5: Finally, resizing the chart to view the nonlinear regression equation properly will result in the plot below showing the nonlinear line of best fit.



[Download Template](#)

This article must be helpful to understand the **Non-linear Regression In Excel**, with its formula and examples. You can download the template here to use it instantly.

[Non-Linear-Regression-In-Excel](#) **Download**

Recommended Articles

This has been a guide to **Non-linear Regression In Excel**. Here we explain how to do Non-linear Regression in excel with examples and downloadable excel template. You may learn more from the following articles –

EXPERIMENT-6

Date:

Aim: Matrix Operations Using Excel: Adding Two Matrices, multiplying a Matrix by a Scalar, Multiplying Two Matrices, transposing a Matrix, inverting a Matrix and Solving System of Linear Equations.

Using MS Excel in Matrix Addition

Example 1: I

If $A = \begin{bmatrix} -2 & 1 & 3 \\ -4 & 0 & 5 \\ 3 & 5 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 0 & -2 \\ 3 & -1 & 1 \\ 4 & -3 & 5 \end{bmatrix}$; Find $A + B$ and name the resulting matrix as C; Solution: a) Enter the matrices A and B anywhere into the Excel sheet as:

	A	B	C	D	E	F	G	H	I	
1			Matrix A					Matrix B		
2		-2	1	3			2	0	-2	
3		-4	0	5			3	-1	1	
4		3	5	2			4	-3	5	

Notice that Matrix A is in cells B2:D4, and Matrix B in cells G2:I4 b) The 2 matrices are 3 by 3, so the resulting matrix will also have 3 rows by 3 columns. Highlight the cells where you want to place the resulting matrix C:

	A	B	C	D	E	F	G	H	I	
1			Matrix A					Matrix B		
2		-2	1	3			2	0	-2	
3		-4	0	5			3	-1	1	
4		3	5	2			4	-3	5	
5										
6										
7										
8					Matrix C = A + B					
9										
10										

c) Once you have highlighted the resulting matrix, and while it is still highlighted, enter the following formula: =B2:D4 + G2:I4

d) When the formula is entered, press the Ctrl key and the Shift key simultaneously, then press the Enter key. This will change the formula you just wrote to: {=B2:D4 + G2:I4}

If you don't press these keys simultaneously (holding down Shift and Ctrl then press Return), the result will appear only in one cell or, you will get some error message).

e) The resulting matrix will be:

Example 2: Repeat the previous example, but this time find $3A - 2B$ and name the resulting matrix as D
Solution: The original formula will be changed to =3*(B2:D4) -2*(G2:I4), the other steps stay the same

Many of the Microsoft Excel functions that you will be using to complete these matrix operations are **array functions** – returning more than one value at a time. To enter an array function into a Microsoft Excel worksheet, you must hold down the CTRL and SHIFT keys while pressing the ENTER key: **CTRL+SHIFT+ENTER** Once this is done, braces will surround the array formula.

	A	B	C	D	E	F	G	H	I	
1			Matrix A					Matrix B		
2		-2	1	3			2	0	-2	
3		-4	0	5			3	-1	1	
4		3	5	2			4	-3	5	
5										
6										
7			Matrix D = 3A - 2B							
8			-10	3	13					
9			-18	2	13					
10			1	21	-4					

Using Microsoft Excel 2007 to Perform Matrix Operations

PURPOSE: This handout was created to provide you with step-by-step instructions on how to perform various matrix operations when using Microsoft Excel 2007.

How to organize (enter) data in matrices:

A computer spreadsheet is a series of small blocks (cells) where the columns are labeled with capital letters and the rows are labeled by numbers. To enter a matrix into Microsoft Excel, simply type each matrix element into its own small block (cell).

	A	B	C	D
1	matrix A:			
2	1	2	3	
3	4	5	6	
4	7	8	9	
5				

Pressing ENTER after each entry will usually make the cursor go down to the next cell. (See the note below.) Pressing the RIGHT ARROW

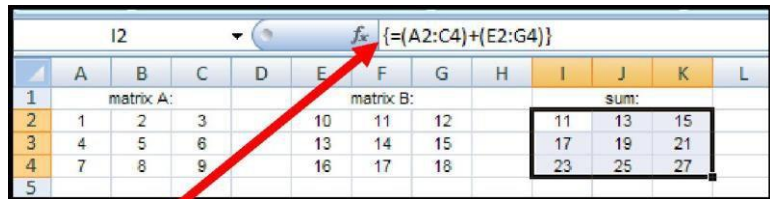
NOTE: The default direction is down, but you can change the direction in which the cursor moves in through the **EXCEL OPTIONS** dialog box:

MICROSOFT OFFICE BUTTON → EXCEL OPTIONS → ADVANCED → UNDER EDITING OPTIONS

How to add matrices:

1. Enter the data of each matrix.
2. Highlight another section of the worksheet (near the given matrices) that has the same dimensions as the answer matrix.

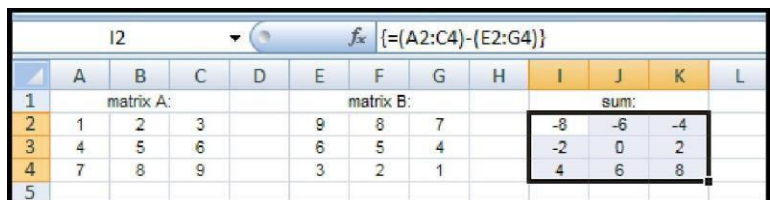
Let's say that we wish to find: $[A] + [B]$
 Since we are adding two 3×3 matrices, the sum matrix will also be 3×3 .



3. Type: **= (A2:C4)+(E2:G4)** (This will appear in the formula bar.)
4. Since this answer will result in an array (matrix), you will need to: **CTRL+SHIFT+ENTER** (NOTE: Braces will surround the formula.)

How to subtract matrices:

1. Enter the data of each matrix.
2. Highlight another section of the worksheet (near the given matrices) that has the same dimensions as the answer matrix.



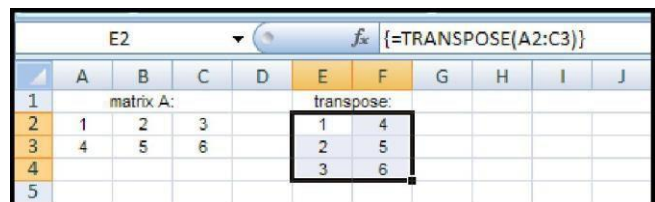
Let's say that we wish to find: $[A] - [B]$

Since we are subtracting two 3×3 matrices, the difference matrix will also be 3×3 .

3. Type: **= (A2:C4)-(E2:G4)** (This will appear in the formula bar.)

4. Since this answer will result in an array (matrix), you will need to: **CTRL+SHIFT+ENTER** **How to find the transpose of a matrix:**

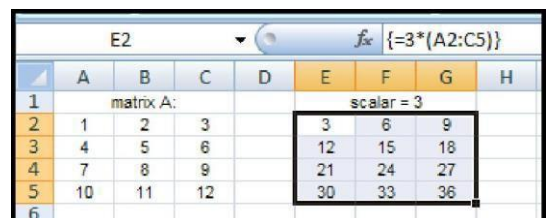
1. Enter the elements of the given matrix.
2. Highlight another section of the worksheet (near the given matrix) that has the same dimensions as the answer matrix.



Since we are finding the transpose of a 2×3 matrix, the answer will be a 3×2 matrix.

3. Type: **= TRANSPOSE (A2:C3)** (This will appear in the formula bar.)
4. Since this answer will result in an array (matrix), you will need to: **CTRL+SHIFT+ENTER** **How to multiply a matrix by a scalar (real number):**

1. Enter the elements of the given matrix.
2. Highlight another section of the worksheet (near the given matrix) that has the same dimensions as the answer matrix.



Let's say that we wish to multiply the given matrix of a scalar of three (3). Since we are multiplying a 4 x 3 matrix by the scalar, our result will also be a 4 x 3 matrix.

- Type: = **3*(A3:C6)** (This will appear in the formula bar.)
- Since this answer will result in an array matrix), you will need to: **TRL+SHIFT+ENTER** How to multiply two matrices:

- Enter the data of each matrix to be multiplied.
- Highlight another section of the worksheet (near the given matrices) that has the same dimensions as the answer matrix.

	A	B	C	D	E	F	G	H	I	J	K	L
1		matrix A:				matrix B						
2	1	2	3		1	2	3		30	36	42	
3	4	5	6		4	5	6		66	81	96	
4	7	8	9		7	8	9		102	126	150	
5					10	11	12		138	171	204	
6												

Let's say that we wish to find the product of matrix A (3 x 3) and matrix B (4 x 3). Recall that the number of columns of the first matrix must be equal to the number of rows of the second matrix to produce a product matrix. Therefore, we must find the product of [B] x [A] – which will be a 4 x 3 matrix.

	A	B	C	D	E	F	G	H	I
1		matrix A:							
2	2	5	4			determinant =	-1		
3	1	4	3						
4	1	-3	-2						
5									

- Type: = **MMULT (E2:G5, A2:C4)** (This will appear in the formula bar.)
- Since this answer will result in an array (matrix), you will need to: **CTRL+SHIFT+ENTER**.

How to find the inverse of a square matrix:

- Enter the square matrix that is to be inverted.
- Highlight another section of the worksheet (near the given matrix) that has the same dimensions as the given square matrix.

Since we were given a 3 x 3 matrix, its inverse will also be a 3 x 3 matrix.

- Type: = **MINVERSE (A2:C4)** (This will appear in the formula bar.)
- Since this answer will result in an array (matrix), you will need to: **CTRL+SHIFT+ENTER** How to find the determinant of a square matrix:

- Enter the given square matrix.
- Highlight a cell of the worksheet (near the given matrix) where you wish the answer to appear.

	A	B	C	D	E	F	G	H	I
1		matrix A:				inverse:			
2	2	5	4		-1	2	1		
3	1	4	3		-5	8	2		
4	1	-3	-2		7	-11	-3		
5									

In the diagram at the right, the answer will appear in cell G2.

- Type: = **MDETERM (A2:C4)** (This will appear in the formula bar.)
- Since this answer will NOT result in an array (matrix) of more than one answer, you may just press **ENTER** to get the result. (However, if you forget – and do **CTRL+SHIFT+ENTER**, you will get the same result.)

How to use inverse matrices to solve systems of linear equations:

How to use inverse matrices to solve systems of linear equations:

Let's say we wish to solve this system of equations:

$$\begin{aligned} 2v + 3w - x + 3y + z &= 22 \\ 3v + w - 4x + 3y - z &= 0 \\ v - 2w + 3x - 4y + 2z &= 0 \\ v + 2w - 3x + 2y - 2z &= -6 \\ 2v &+ 4y - 5z = -7 \end{aligned}$$

The matrix equation for this system is:

$$\begin{bmatrix} 2 & 3 & -1 & 3 & 1 \\ 3 & 1 & -4 & 3 & -1 \\ 1 & -2 & 3 & -4 & 2 \\ 1 & 2 & -3 & 2 & -2 \\ 2 & 0 & 0 & 4 & -5 \end{bmatrix} \times \begin{bmatrix} v \\ w \\ x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 22 \\ 0 \\ 0 \\ -6 \\ -7 \end{bmatrix}$$

- Enter the data for the coefficient matrix and the constant matrix (as shown).
- Find the inverse of the coefficient matrix:

	A	B	C	D	E	F	G	H
1	coefficients:					constants:		
2	2	3	-1	3	1		22	
3	3	1	-4	3	-1		0	
4	1	-2	3	-4	2		0	
5	1	2	-3	2	-2		-6	
6	2	0	0	4	-5		-7	
7								

- Highlight: cells A9 to E13
- Type: =**MINVERSE (A2:E6)**

	A	B	C	D	E	F	G	H	I
1	coefficients:					constants:			
2	2	3	-1	3	1		22		
3	3	1	-4	3	-1		0		
4	1	-2	3	-4	2		0		
5	1	2	-3	2	-2		-6		
6	2	0	0	4	-5		-7		
7									
8	inverse matrix:					answers:			
9	0.096	0.121	0.259	0.069	0.069				
10	0.207	-0.31	0.121	0.466	-0.034				
11	0.155	-0.183	0.066	-0.076	0.124				
12	0.086	0.121	-0.241	-0.431	0.069				
13	0.103	0.145	-0.09	-0.317	-0.117				
14									

- Multiply the "inverse matrix" by the constant matrix:

- Highlight: cells G9 to G13
- Type: =**MMULT(A9:E13,G2:G6)**
- Remember to **CTRL+SHIFT+ENTER**.

The answers to the given system will appear in the resulting matrix. In the given example, the solutions are: v = 1, w = 2, x = 3, y = 4, z = 5

	A	B	C	D	E	F	G	H	I	J
1	coefficients:					constants:				
2	2	3	-1	3	1		22			
3	3	1	-4	3	-1		0			
4	1	-2	3	-4	2		0			
5	1	2	-3	2	-2		-6			
6	2	0	0	4	-5		-7			
7										
8	inverse matrix:					answers:				
9	0.086	0.121	0.259	0.069	0.069		1	v		
10	0.207	-0.31	0.121	0.466	-0.034		2	w		
11	0.155	-0.183	0.066	-0.076	0.124		3	x		
12	0.086	0.121	-0.241	-0.431	0.069		4	y		
13	0.103	0.145	-0.09	-0.317	-0.117		5	z		
14										

Recall: A matrix will have no inverse if its determinant is zero. So, before attempting to find the inverse of a coefficient matrix, you may want to check the value of its determinant. If the coefficient matrix of a system of linear equations has a determinant equal to zero, the system will not have a unique solution. And, you will have to find the general solution by hand – using the Gauss-Jordan Elimination Method.

System of Linear Equations

This example shows you how to solve a system of linear equations in Excel. For example, we have the following system of linear equations:

$$5x + 1y + 8z = 46$$

$$4x - 2y = 12$$

$$6x + 7y + 4z = 50$$

In matrix notation, this can be written as $AX = B$

If A^{-1} (the inverse of A) exists, we can multiply both sides by A^{-1} to obtain $X = A^{-1}B$. To solve this system of linear equations in Excel, execute the following steps.

1. Use the MINVERSE function to return the inverse matrix of A. First, select the range B6:D8. Next, insert the MINVERSE function shown below. Finish by pressing CTRL + SHIFT + ENTER.

	A	B	C	D	E	F	G	H	I	J
1										
2		5	1	8			46			
3	A	4	-2	0		B	12			
4		6	7	4			50			
5										
6		-0.0303	0.197	0.0606						
7	A ⁻¹	-0.0606	-0.1061	0.1212						
8		0.1515	-0.1098	-0.053						
9										

Note: the formula bar indicates that the cells contain an array formula. Therefore, you cannot delete a single result. To delete the results, select the range B6:D8 and press Delete.

2. Use the MMULT function to return the product of matrix A^{-1} and B. First, select the range G6:G8. Next, insert the MMULT function shown below. Finish by pressing CTRL + SHIFT + ENTER.

	A	B	C	D	E	F	G	H	I	J
1										
2		5	1	8			46			
3	A	4	-2	0		B	12			
4		6	7	4			50			
5										
6		-0.0303	0.197	0.0606			4			
7	A ⁻¹	-0.0606	-0.1061	0.1212		X	2			
8		0.1515	-0.1098	-0.053			3			
9										

3. Put it all together. First, select the range G6:G8. Next, insert the formula shown below. Finish by pressing CTRL + SHIFT + ENTER.

	A	B	C	D	E	F	G	H	I	J
1										
2		5	1	8			46			
3	A	4	-2	0		B	12			
4		6	7	4			50			
5										
6							4			
7						X	2			
8							3			
9										

4. If you have Excel 365 or Excel 2021, simply select cell G6, enter the same formula as above and press Enter. Bye bye curly braces.

	A	B	C	D	E	F	G	H	I	J
1										
2		5	1	8			46			
3	A	4	-2	0		B	12			
4		6	7	4			50			
5										
6							4			
7						X	2			
8							3			
9										

Note: this dynamic array formula, entered into cell G6, fills multiple cells. Wow! This behavior in Excel 365/2021 is called spilling.

EXPERIMENT-7

Date:

Aim: VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The for Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function the Excel Object Model, For Each Next Structure.

Syntax of the Select Case Statement of Excel VBA

The Select Case statement in VBA is similar to the Switch Case statement used in programming languages like Java, C#, PHP, etc. The syntax of the Select Case statement of Excel VBA is given as follows:

Select [Case] Expression for testing

[Case] List of Expression Statements (Case 1, Case 2, Case 3 and so on...)

Case Else (Else Statements)

**End
Select
End Sub**

The Select Case statement of Excel VBA accepts the following arguments:

- **Expression for testing:** This is a single expression that is to be compared with the different Cases. It can either be a numeric or textual expression. So, it can evaluate to a character, integer, Boolean, object, string, etc.
- **List of expressions:** This is the list of expressions (called Case statements) against which the "expression for testing" is compared. Excel VBA looks for an exact match within these Case statements. These Case statements consist of one or more possible outcomes (values or conditions) that may or may not match the "expression for testing." If there are multiple expressions (or values) within a single Case, they must be separated by commas. The following keywords can be used in Case statements:
 - o The To keyword should be used when a range of values needs to be specified in a Case statement. The value preceding the To keyword should be less than or equal to the value succeeding this keyword.

o The Is keyword should be used when a **logical operator** (=, <>, <, >, <= or >=) needs to be entered in a Case statement. This keyword should be inserted before the logical operator.

- **Statements:** This is one or more codes succeeding the "list of expressions." Only that code is executed for which the "expression for testing" matches the "list of expressions."
- **Case Else statement:** This consists of one or more codes (or statements), which are executed when all the Case statements (or list of expressions) are false.
- **End Select:** It closes the Select Case structure. Every Select Case statement must necessarily have an End Select statement.

The "expression for testing," "list of expressions," and End Select clauses are required in a Select Case construction. However, the "statements" and Case Else statements are optional in the given syntax.

Note 1: In a Select Case statement in VBA, each Case statement is compared with the "expression for testing." Once a condition is met (or the Case statement is matched), no further Case statements are tested. However, if a condition is false (or the Case statement does not match), the next Case statement is tested.

The testing of Case statements (or conditions) continues till one of the specified conditions is met or till the Case Else or the End Select statement. If none of the tested conditions is true and there is no Case Else statement, control passes to the End Select statement.

Note 2: If the "expression for testing" matches more than one Case statement, only the code of the first such match is executed.

How to use the Select Case Statement of Excel VBA?

The Select Case statement is a feature of Excel VBA. One can access VBA from the "visual basic" option of the [Developer tab of Excel](#). In this tab, the user-defined functions (UDF) and their codes can be created.

The Select Case statement of VBA should be used in place of the [nested If- statement](#) of Excel. This is because the former is easier to understand and execute than the latter.

The steps to use the Select Case statement of VBA are listed as follows:

- a.** Create a command button and place it in the Excel worksheet. When the command button is clicked, a **macro** runs. The running of the macro performs an action.
- b.** Right-click the command button and choose the option "view code." The Visual Basic Editor opens.
- c.** Enter the code between the CommandButton function and End Sub.

d. Debug and compile the code to identify the syntax errors.

e. Change the input values to observe the different outputs.

Note 1: The user-defined functions (UDF) are customized functions that cater to the specific needs of the user.

Note 2: Every time the input is changed (in point e), the "expression for testing" changes. As a result, the conditions that match this expression change. Hence, different codes are executed each time the input values change.

VBA Select Case Examples

You can download this VBA Select Case Excel Template here — [VBA Select Case Excel Template](#)

Example #1 "Expression for Testing" is Entered Directly

In the following code, the "expression for testing" is A=20 and the Case statements are 10, 20, 30, and 40. There is also a Case Else statement in this code.

```
Private Sub Selcaseexample(Dim A As Integer
```

```
A = 20
```

```
Select Case A
```

```
Case 10
```

```
MsgBox "First Case is matched!"
```

```
Case 20
```

```
MsgBox "The Second Case is matched!"
```

```
Case 30
```

```
MsgBox "Third Case is matched in Select Case!"
```

```
Case 40
```

```
MsgBox "Fourth Case is matched in Select Case!"
```

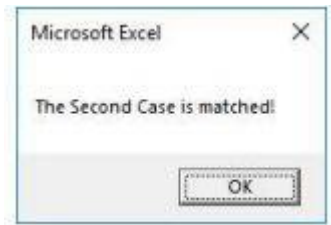
On running the preceding code, the following output is obtained.

Case Else

```
MsgBox'NoneoftheCasesmatch!'
```

```
End Select
```

```
End Sub
```



Explanation: The expression $A=20$ is compared with the four Case statements 10, 20, 30, and 40. A match is found in the second Case statement (Case 20). Consequently, the message of the second Case statement is displayed, which is "the second Case is matched."

Had the expression not matched with any of the Case statements, the message of the Case Else statement would have been displayed.

Note: The MsgBox function of VBA displays a dialog box containing a customized message.

Example #2-"Expression for Testing" is Compared with a Range of Values Using the "To" Keyword

In the following code, the "expression for testing" is collected from the user with the help of the InputBox function of VBA. There are four Case statements, namely Case 1 To 36, Case 37 To 55, Case 56 To 80, and Case 81 To 100. There is also a Case Else statement in the code.

```
Private Sub Selcasetoexample
```

```
Dim studentmarks As Integer
```

```
studentmarks = InputBox("Enter marks between 1 to 100.")
```

```
Select Case studentmarks
```

```
Case 1 To 36
```

```
MsgBox
```

```
"Fail!"
```

```
Case 37 To 55
```

```
MsgBox "C
```

```
Grade"
```

```
Case 56 To 80  
MsgBox "B  
Grade"
```

```
Case 81 To 100  
MsgBox "A  
Grade"
```

```
Case Else  
MsgBox "Out of range"
```

```
End  
Select  
End Sub
```

On running the preceding code, the user is asked for input. Assume that the user enters 90. So, the following output is obtained.



Explanation: The Case statements of the preceding code contain a range of values. Notice that in the code, each number preceding the To keyword is smaller than the number succeeding this keyword.

The "expression for testing" is entered as 90 by the user. This expression matches the fourth Case statement (Case 81 to 100). So, the code in this Case statement is executed. Hence, the message "A grade" is returned by VBA. This output is displayed in a dialog box due to the usage of the Msg Box function in the code. Both numbers (preceding and succeeding the To keyword) of the range are inclusive. So, had the user entered 81, it would have again matched with the fourth Case statement. However, had a number greater than 100 been entered, the output would have been "out of range." This message is defined in the Case Else statement of the code.

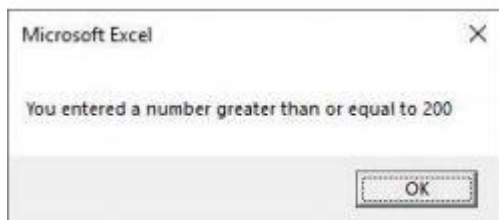
Note: The InputBox function collects the input from the user through a dialog box. The message shown in this dialog box is the same as that entered in the InputBox function of the code.

Example #3-"Expression for Testing" is Compared with Numbers Using the "Is" Keyword

In the following code, the "expression for testing" is collected from the user. There are two Case statements, namely Case Is < 200 and Case Is >= 200. There is no Case Else statement in the code.

```
Sub CheckNumber()  
    Dim NumInput As Integer  
    NumInput = InputBox("Please enter a number.")  
  
    Select Case NumInput  
  
        Case Is < 200  
            MsgBox "You entered a number less than 200"  
  
        Case Is >= 200  
            MsgBox "You entered a number greater than or equal to 200"  
  
    End  
    Select  
End Sub
```

On running the preceding code, a dialog box containing the message "please enter a number" is displayed. Assume that the user enters 200. So, the following output is displayed.



Explanation: Observe that the two logical operators (< and >=) in the code are preceded by the "Is" keyword. Had this keyword not been supplied, VBA would have automatically inserted it before the logical operators.

The "expression for testing" is entered by the user as 200. This expression is compared with the two Case statements of the preceding code. A match is found in the second Case statement. This is because 200 is not greater than but is equal to 200.

Notice that there is no Case Else statement in the preceding code. This is because whatever number the user enters, it falls within either of the two Case statements. So, one of the two Case statements will always be true. Hence, the Case Else statement is not required as it runs only when all Case statements evaluate to false.

Example #4-"Expression for Testing" is Entered in a

Cell and Evaluated by the Command Button

In the following code, the "expression for testing" is taken from cell A1 of the Excel worksheet. There are three Case statements and one Case Else statement.

```
Sub color()  
Dim color As String  
color = Range("A1").Value  
  
Select Case color  
  
Case "Red", "Green", "Yellow" Range("B1").Value  
    = 1  
  
Case "White", "Black", "Brown" Range("B1").Value  
    = 2  
  
Case "Blue", "Sky", "Blue"  
    Range("B1").Value = 3  
  
Case Else  
    Range("B1").Value = 4  
  
End Select  
End Sub
```

Further, a command button has been created in the worksheet with the help of ActiveX controls. The input entered in cell A1, the command button, and the output obtained in cell B1 are shown in the following image.

	A	B	C	D	E
1	pink	4			
2					
3			CommandButton2		
4					
5					
6					

Explanation: The preceding code is executed by clicking the command button of the Excel worksheet. Notice that multiple expressions of each Case statement are separated by commas (like "Red", "Green", "Yellow").

The "expression for testing" is entered as "pink" in cell A1. This expression matches none of the three Case statements specified in the code. Consequently, the code of the Case Else statement is executed. So, the output in cell B1 is 4.

Had the user entered a color (in cell A1) specified in any of the three Case statements, the corresponding code would have run. For instance, had the user entered "White" in cell A1 (without the double quotes and with "W" capital), the output in cell B1 would have been 2.

Hence, a change in the input of cell A1 causes the output of cell B1 to change.

Example #5-"Expression for Testing" is Divided by 2 with the MOD Operator of VBA

In the following code, the "expression for testing" is collected from the user. There are two Case statements, namely Case True and Case False. The Case Else statement is not there in the code.

```
Sub CheckOddEven()  
CheckValue=InputBox('Enter a number:')
```

```
Select Case (CheckValue Mod 2)=0
```

```
Case True
```

```
MsgBox 'The number is even'
```

```
Case False
```

```
MsgBox 'The number is odd'
```

```
End Select
```

End Sub

VBA If Else statements

Building a VBA If Else^[1] statement is quite similar to building a [nested if formula](#) inside Excel. The benefit of using [VBA](#) instead is that it's much easier to follow, since nested IFs tend to complicate with multiple parenthesis enclosures. In a VBA if statement, each IF clause is separate from the other, and is instead laid out in order of priority from top to bottom.

If Statement Structure in VBA

If Range("A5") = "YES" Then

Range("A5").Value = "NO"

End If

- If statements begin with an If [CRITERIA] Then statement
- If the user does not wish to add additional statements, the if statement is closed by an End If
- In the above example, no false statement is present. Thus, if Cell A5 is not YES, VBA will simply skip this statement and move on to whatever code follows it. If Cell A5 is YES, the process contained in the If statement will be run.

If Range("A5") <= 100 Then

Range("A6").Value = "Decent Performance"

Else If Range("A5") > 100 Then

Range("A6").Value = "Great Performance"

End If

- If the user does want to add additional statements assuming the first If ... Then is false, then the first if...then the process should be immediately followed by the Else If...Then statement.
- There can be multiple Else If...Then clauses in a VBA if statement, as long as each Else If ... criteria is mutually exclusive from other Else If or If criteria.
- End If should close the last Else If...Then statement.
- In the above example, if Cell A5 is 91, then Cell A6 will be set to Decent Performance.

If Range("A5") <= 50 Then

Range ("A6").Value = "Failing Grade"

Else If Range ("A5") <= 80 Then

Range("A6").Value = "Passing Grade"

Else

Range("A6").Value = "Outstanding Grade"

End If

- The user can also elect to include one Else statement, which will activate if all other If and Else If statements are false.
- Else statements are not followed by Then, unlike If...Then and Else If...Then statements.
- End If should close an Else statement and only the Else statement, if it is used.
- In the above example, if Cell A5 is 91, then Cell A6 will be set to Outstanding Grade.
- Else statements act as a "catch-all" and will ensure that one process is run even if all the other If statements are false.
- Excluding an Else statement may result in the entire if to end if statement being skipped over if all criteria are false.

An If formula in [Excel worksheets](#) needs a clause to perform if the statement is true and one to perform if the statement is false. In contrast, a VBA if statement only needs code to perform if the statement is true. The section defining what to perform if that statement is false is optional. If the VBA statement turns out to be false and no process is defined for a false statement, then VBA will simply skip the if statement and move on to the next

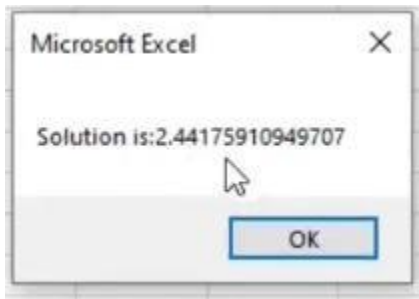
Function $x^3+x-17=0$

```
Sub bisection()  
Dim i As Integer, a As Double, b As Double, Mid As Double, fa As Double, fb As Double, fmid As Double
```

```
a = InputBox("enter the low bound")  
b = InputBox("enter the high bound")
```

```
For i = 1 To 20
  Mid = (a + b) / 2
  fa = given(a)
  fmid = given(Mid)
  If fa * fmid < 0 Then
    b = Mid
  Else
    a = Mid
  End If
Next i
MsgBox ("Solution is:" & (a + b) / 2)
End Sub
```

```
Function given(x)
```



```
Next i
MsgBox ("Solution is:" & formatnumber((a + b) / 2,2))
```

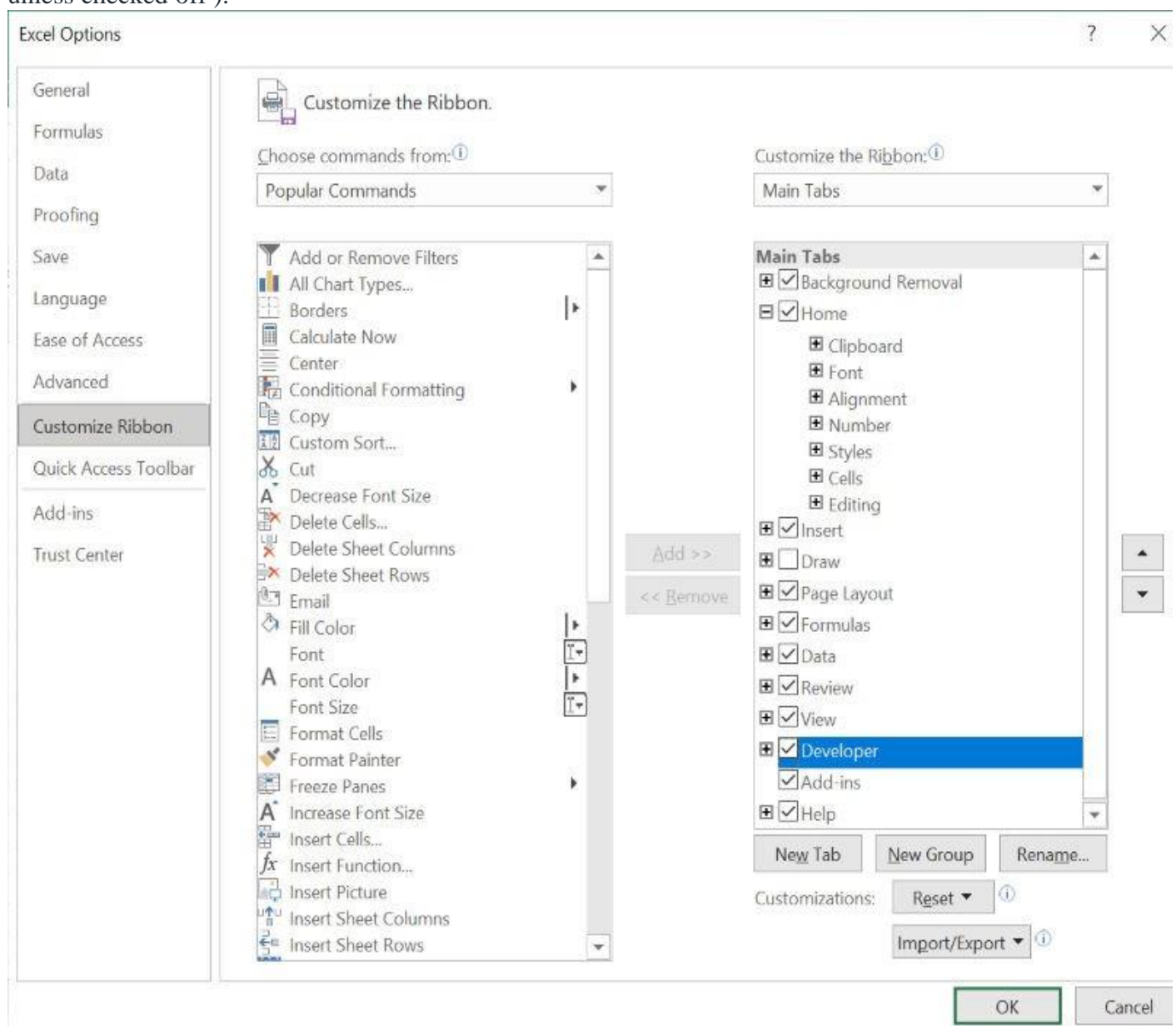


EXPERIMENT-8**Date:**

Aim: VBA Subroutines or Macros: Recording a Macro, coding a Macro Finding Roots by Bisection, Using Arrays, adding a Control and Creating User Forms.

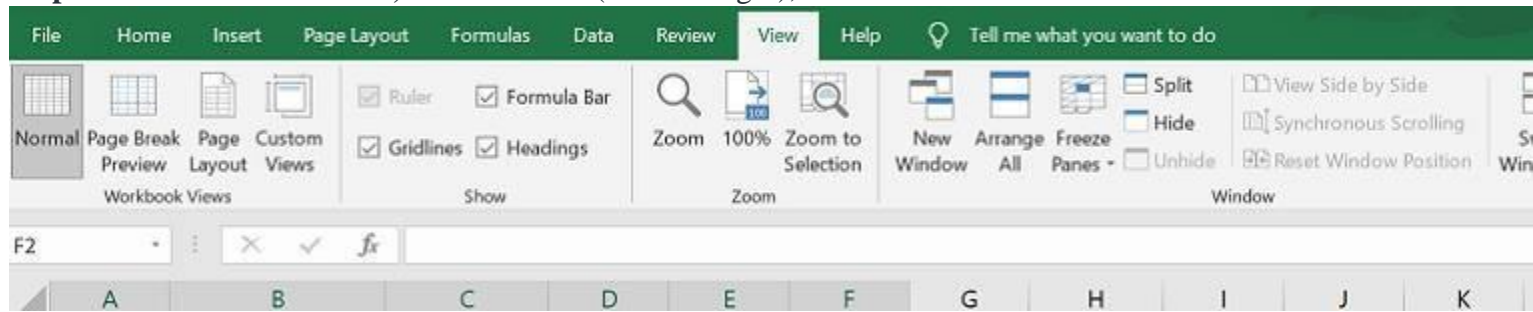
Excel Macro is simply a record button that records a set of actions performed on Excel that can be run multiple times. For example, if you have to format some raw data on weekly basis you can use a macro to record yourself formatting the data once and let excel automate the task in the future. it's used to help users save time and avoid performing redundant tasks.

In order to record a macro the **Developer tab** on the ribbon needs to be activated as it isn't on by default within Microsoft Excel. The developer tab contains all the macro tools among various other features. To activate it click on the **file tab > goto options > Customize Ribbon Under Customize the Ribbon** and under **Main Tabs**, select the **Developer** check box. (The developer tab stays on the ribbon unless checked off).

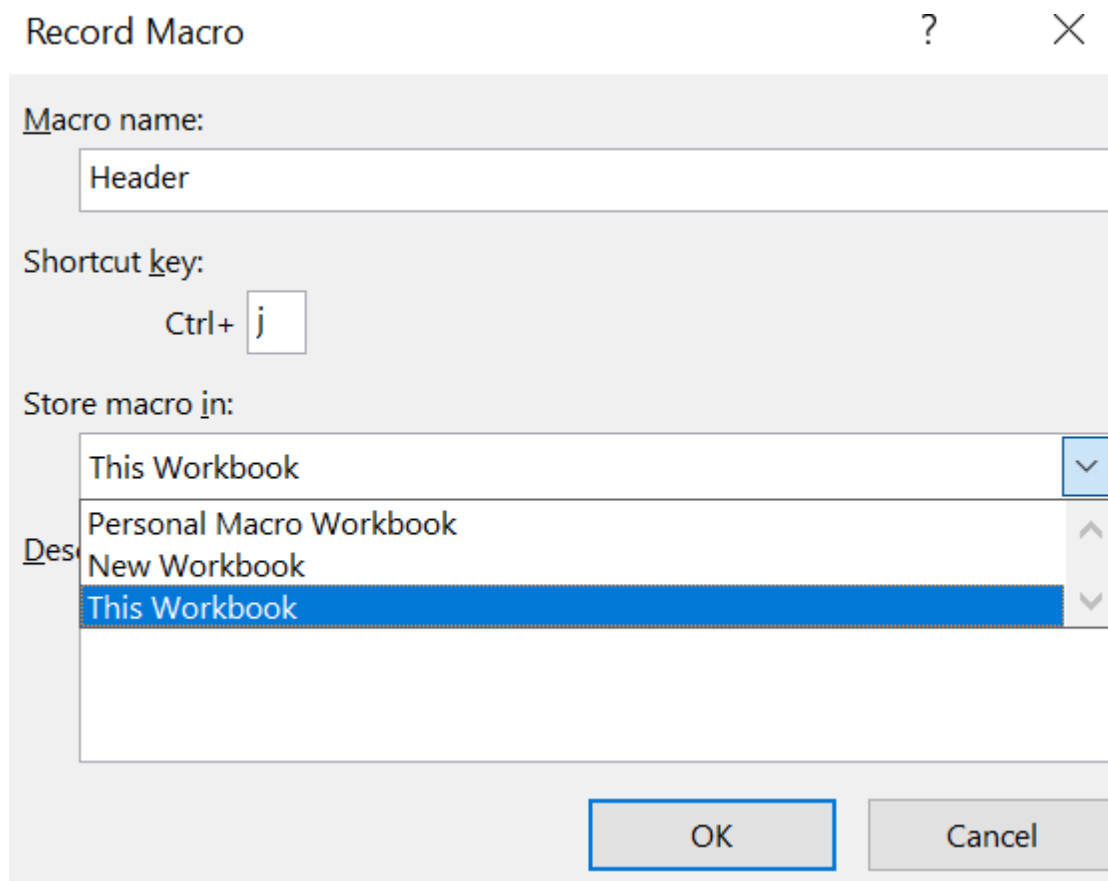


To record a macro follow these steps :

Step 1: click on the **view tab**, select **Macros**(extreme right), and hit **Record Macro**.



Step 2: A **Record Macro** dialog box pops up.



The record macro dialog box has 4 sections to be filled

- Macro name: give a name to your macro (avoid spaces and keep it short)
- Shortcut Key: you can select any letter to create a shortcut key, be careful not to override an existing shortcut key. (you can press **shift** and any letter in the box to create a **ctrl+shift+letter** key)
- Store macro in: select **This workbook** to run it only in the current workbook, **personal macro workbook** so the macro can be used within any workbook on the computer that contains that personal macro workbook and **new workbook** to run it in a new workbook it creates at the time of recording.

- Description: Here you can provide additional information about the macro(what it does) for the users or ourselves.

Step 3: Click **ok** and Excel will start recording all of your actions henceforth.

Step 4: Once done, remember to hit the **stop recording button** in the lower-left corner of the worksheet or head over to **view>Macros>stop recording**.

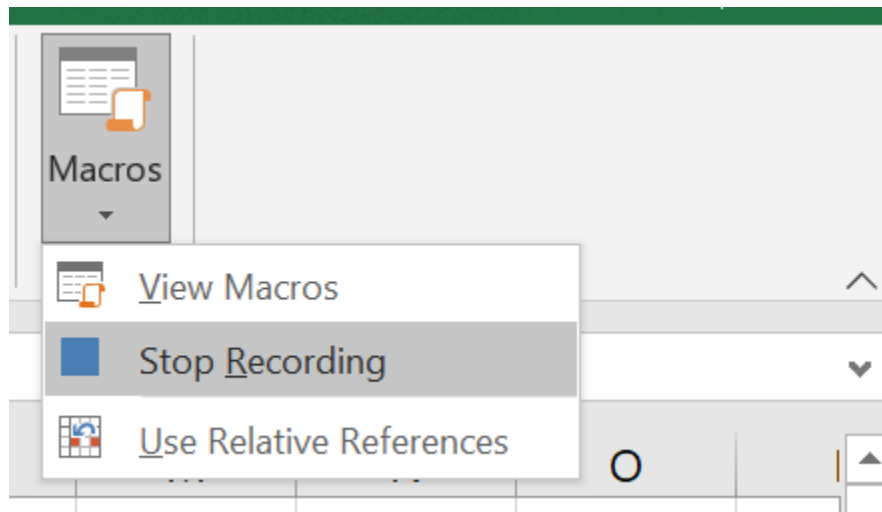
16	East	Clerical Support	25000
17			

EAST RECORDS **RUN MACRO**

Enter Scroll Lock

Windows logo Type here to search

Stop recording button bottom left corner.



The above steps should help you get started recording a macro.

The Visual Basic Editor

Excel has a tool called the Visual Basic Editor or VBA that makes note of all the actions you perform while recording a macro in the backend. When you record a macro inside excel through the macro recorder all the code gets stored in a module. To see the code that excel has written head to the Developer tab>code section>Visual Basic this opens up a separate window called the Visual Basic Application window along the left side of this window you will find the module under the project Explorer(if you don't see it click on View>Project Explorer) double click it and all the text is the code that excel generated while recording the macro.

Absolute and Relative recording:

A macro can be recorded in 2 ways namely Absolute and Relative recording. When you record a macro in Excel it is by default in the Absolute recording mode. In the absolute recording, the steps are performed exactly in the cells the steps were recorded in despite the active cell. In simple words, absolute recording restricts the location of steps. Relative recording executes the steps recorded in any part of the worksheet selected by the user as its relative to the starting location of the macros. To turn on Relative recording head to **Developer tab>Code>Use Relative References**(gets highlighted in grey when selected) and then start recording the macro.

Limitations of an Excel Macro:

Macros have certain limitations pertaining to them and can be combated by writing the VBA code manually. Some of them are as follows

- A macro doesn't record what options you select within a dialog box.
- If you need to make any decisions in your process (code), the macro recorder can't help you make them. you can use the IF statement or other conditional statements.
- The macro recorder can't throw message boxes to prompt the user.

Macro-Enabled File Extensions:

There are some file extensions that do not store a macro hence you need to be careful about using a macro-enabled format to save your workbook or the macro won't be saved.

The default Excel format of the Excel workbook is .xlsx which does not support macros. To store macros you save and open workbooks in a new macro-enabled workbook format .xlsm. this format is the same as .xlsx, but with the capability to support Excel macros.

The Excel Binary Workbook(.xlsb) and Excel macro-enabled template(.xltm) are some more file extensions that support macros within them.

Steps to save a macro-enabled workbook :

- Click on the File tab and then choose Save As. The Save As dialog box appears.
- Enter a name for the and select a location for your workbook.
- Click the Save as Type drop-down arrow. A list of file types appears.
- Select Excel Macro-Enabled Workbook. Click on Save.

Some more real-time applications of macros can be used to record the creation of charts based on some data, filtering and sorting data, formatting data, or importing it

References:

McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition.