UNIT 17  FORMULAS AND FUNCTIONS

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17.0  OBJECTIVES

After completing this unit, you should be able to:

- understand the basic features of Excel such as the creation of worksheets and computation of data;
- understand the basic formulas available in MS Excel;
- understand how to construct and insert formulas; and
- learn about various kinds of Functions available in MS Excel, and their uses.

17.1  INTRODUCTION

At home, we keep a track of our own budgets and investments, and at office, we have numerous tasks to perform, which may be related to accounting, analytics, sales or budgeting. Businesses also need graphs and charts for data analysis and projections. Further, Mathematics and Engineering students have to deal with large numbers, formulas and calculations, in which
Spreadsheets are one of the best software to use. Moreover, almost all of us face-off with tables and datasets day-to-day for which, there are many software packages available to assist us in all the above stated functions. Electronic spreadsheets are most common tools to handle such requirement. Spreadsheets are integrated with ways to organize data by grouping it into rows and columns; they are used to organize, analyze and manipulate all type of data and provide enhanced functionalities for numerical datasets. There are quite a few electronic spreadsheet programs available like Microsoft Excel, Open Office Calc or Google spreadsheets. We will consider MS Excel for our study. It comes bundled in Microsoft Office, which is an office automation tool. Microsoft Excel is one of the highly regarded spreadsheet software, which is used by people in their daily routine jobs. In this unit we will discuss the basic functionalities of Microsoft Excel, used to store, maintain, manage, manipulate and organize our data.

17.2 FORMULAS

Microsoft Excel consists of many powerful formulas and functions, which can be used for various problems, whether it is financial, logical, statistical or mathematical. A Formula, in MS Excel, is an expression, which consists of values, operators and conditions, applied over a cell or a range of cells.

17.2.1 Constructing Formulas

To insert/construct a formula in MS Excel, follow the following steps:

1) Select a cell with your cursor.
2) Type in the “=” sign. Every formula in MS Excel starts with the “=” sign.
3) For Example, let us start with a simple formula of addition.
4) After the “=” sign, select the cells to be added or type in their cell reference, like B2, C3, etc.
5) The screen will reflect like the following figure:

![Fig. 17.1: Constructing Formula](image)

6) The result of the formula is shown as follows:
17.2.2 Array Formulas

An array is a combination of either a row of values, column of values or both the row and column of values. An array formula can perform multiple no. of calculations on one or more cells of an array. It can give both single and multiple cell results. Array formulas are also known as CSE (Control + Shift + Enter) Formula.

To insert an array formula, follow the following steps:

1) Let us take an example of a computer shop buying certain products. We have created a following table for the same:

2) Insert array formula, it is required to select the entire cell range on which the multiple cell array formula has to be applied.

3) Then, enter the formula as shown in the below figure:
4) When you enter the formula, rather than pressing Enter, use a combination of Ctrl + Shift + Enter. It will show the formula covered with brace bracket characters. Same formula will appear on every cell, on which the formula is applied.

5) An array formula can also be applied on a single cell. All the process remains the same, but entire cell range shall not be required before application of formula; just that single cell is selected on which the formula has to be applied.

17.3 FUNCTIONS

A function, in MS Excel, can be termed as a pre-structured or pre-defined formula that can calculate certain results using the selected specific values. A function is based on a certain basic syntax. It includes an equal sign “=” , the name of the function, like SUM, PRODUCT, IF and at last, the argument(s). Arguments are entered in a bracket; they contain the information that is to be calculated.

17.3.1 Inserting Functions

To insert a function, see the below steps:-

1) Select the Formulas tab on the menu ribbon.
2) Select a function from the horizontal list, as shown below in Fig. 17.5.
3) Let us take an example of SUM.

4) This function is available under Math & Trig tab.

Fig. 17.6: Math & Trig Tab Section

5) When we click on this option, syntax will appear on the selected cell, and a dialog box would appear.

Fig. 17.7: Sum Formula

6) We need to put in the required information for the function to calculate, in this case the cells that need to be added.
7) After putting in the information, press OK.

8) This will result in provision of selected cells sum, as in the figure 17.9, but needful is to contain numerical values in the cells under process.

17.3.2 Built-in Function

As we can see in the below figure, there are broadly six types of built-in functions in MS Excel, namely,
1) Financial Functions
   a) **PMT**: This function is used for calculating periodical installments for a loan at a constant interest rate.
   b) **PV**: This function is used for calculating the Present Value of a given Loan as an Investment Amount at fixed rate of interest.
   c) **FV**: This function is used for calculating the Future Value of the current investment amount; calculation is dependent on the fixed rate of interest.

2) Logical Functions
   a) **IF**: It makes a logical comparison between the value and the expected value.
   b) **AND**: This is basically a supportive function for making better logical comparisons. Its outcome goes TRUE keeping all the inputs TRUE and results FALSE if one or more inputs are FALSE.
   c) **OR**: This function is also a supportive logical function, but it works on the following basis of logic, its resultant outcome becomes TRUE if one or more inputs provides TRUE and results FALSE if all the inputs provided FALSE.

3) Text Functions
   a) **CONCATENATE**: It combines two or more text strings into one single cell.
   b) **DOLLAR**: It converts a number to text with a dollar sign as its prefix.

4) Date & Time Functions
   a) **DATE**: This function returns selected cells in a date (mm/dd/yyyy - default) format.
   b) **MONTH**: It results the name of the month, given any number between 1(JAN) to 12(DEC).

5) Lookup & Reference Functions
   a) **VLOOKUP**: This is a very popular function. It refers to the value of provided input in the leftmost column of given dataset in the form of selected cells and results with the value from the matching row of a different/selected column.
   b) **MATCH**: It returns with the relative position of the required value from an array that matches a specified value.

6) Math & Trig Functions
   a) **SUM**: It returns with the sum of the selected cells, given the selected cells are numerical values.
   b) **PI**: It resultant outcome is mathematical value of PI i.e. (3.14159265) precisely till 15 decimal places.
   c) **PRODUCT**: These results in the multiplication of the selected cells, given those cells are numerical values.
17.4 MATHEMATICAL FUNCTIONS

Mathematics is an inevitable part of any decision making, Microsoft Excel categorically provide the set of functions to handle mathematical problems. There is a separate category of Math & Trig functions dealing into providing support for mathematical and trigonometric challenges.

Fig. 17.11: Mathematical Formulas

Adding and subtracting in Excel is easy; you just have to create a simple formula to do it. Remember that all formulas in Excel begin with an equal sign (=), and we have the formula bar to create and edit them.

Add two or more numbers in one cell, Click any blank cell, and then type an equal sign (=) to start a formula. After the equal sign, type a few numbers separated by a plus sign (+).

For example, 40+21+14+3. Press RETURN, the result is 78.

Subtract two or more numbers in a cell, click any blank cell, and then type an equal sign (=) to start a formula. After the equal sign, type a few numbers that are separated by a minus sign (-).

For example, 70-20-15-3. Press RETURN, if you use the example numbers, the result is 32.

Mathematical function sum() described below:

Sum() function:

This function is used to add two or more numbers, by providing their respective cell addresses. The cell addresses provided by using operators or directly as a cell range to the function. The result is addition of given numbers in general conditions, but it changes when there are some gaps in the cell ranges.
The sum() function needs cell addresses of numbers to be passed as arguments. Text and Logical Values are ignored in cells, only included if typed as arguments.

Subtract numbers using cell references

A cell reference combines the row number and column letter, like A1 or F345. When you use cell references in a formula instead of the cell value, you can change the value in that cell without having to change the formula.

1) Type a number in cells C1 and D1. For example, 5 and 3.
2) In cell E1, type an equal sign (=) to start the formula.
3) After the equal sign, type \( C1-D1 \).

![Fig. 17.14: Subtract Function](image)

4) Press RETURN, If you used the example numbers, the result is 2.
Some best practices for working with the SUM function.
The \( =1+2 \) or \( =A+B \) Method – While you can enter \( =1+2+3 \) or \( =A1+B1+C2 \) and get fully accurate results, these methods can be error prone for several reasons:

1) Typos – If you enter more and/or much larger values like this:
\[
=14598.93+65437.90+78496.23
\]
Now try to validate that the entries are correct. It is much easier to put these values in individual cells and use a SUM formula. In addition, you can also format the values when they are in cells.

![Fig. 17.15: Use of SUM Function](image)

Use the SUM function instead of hard-coding values in formulas.
Formula in cell D5 is \( =\text{SUM(D2:D4)} \)

2) \#VALUE! Errors, when referencing text instead of numbers

If you use a formula like:
\[
=A1+B1+C1 \text{ or } =A1+A2+A3
\]

![Fig. 17.16: \#VALUE! Error](image)

Example of a poor formula construction: Formula in cell D2 is \( =A2+B2+C2 \)

Your formula can break if there are non-numeric values in the referenced cells, which will return a \#VALUE! Error. SUM will ignore the text values and provide the sum of just the numeric values.
Proper formula construction - Instead of \( =A2+B2+C2 \), use \( =\text{SUM}(A2:C2) \)

3) #REF! error from deleting rows or columns

#REF! error caused if a column is deleted. Formula has changed to 
\( =A2+#\text{REF}!+B2 \)

If you delete a row or column, the formula will not update to exclude the deleted row and it will return a #REF! error, where a SUM function will automatically update.

SUM function will automatically adjust for inserted or deleted rows and columns.

4) Formulas will not update references when inserting rows or columns

=\( A+B+C \) formulas will not update if you add rows

Dependent upon your inserted values in a row or column, the formula shall not update to include the adjustments made, where as a benefits of
using SUM function is that it will automatically update itself (as long as you are not outside of the range referenced in the formula). This is especially important if you expect your formula to update and it does not, as it will leave you with incomplete results that you might not catch.

Fig. 17.21: Positives of SUM Function

Example portrays a SUM formula automatically expanding from =SUM(A2:C2) to =SUM(A2:D2) when a column was inserted.

5) SUM with individual Cell References vs. Ranges

Using a formula like “=SUM(A1,A2,A3,B1,B2,B3)” is equally error prone when we insert or delete rows within the referenced range for the same reasons, as given above. It’s much better to use individual ranges, like “=SUM(A1:A3,B1:B3)”.

It will automatically update when adding or deleting rows.

Multiplication in Excel is easy; you just have to create a simple formula to do it. As we already know that all formulas in Excel begin with an equal sign (=), and you can use the formula bar to create them.

To multiply two or more numbers in one cell, Click any blank cell, and then type an equal sign (=) to start writing a formula. After the equal sign, type a few numbers separated by a multiplication sign (*).

For example, 40*21. Press RETURN, the result is 840.

Apart from above method mathematical function for multiplication product() described below:

**Product() function:**

The PRODUCT function multiplies all the numbers entered and returns the product. For example, if cells A1 and A2 contain numbers, you can use the formula =PRODUCT(A1, A2) to multiply the two numbers together. You can also perform the same function by using the multiply (*) operator; like, “=A1 * A2”.

The PRODUCT function is better when you need to multiply many cells together. For example, the formula =PRODUCT(A1:A3, C1:C3) is same as =A1 * A2 * A3 * C1 * C2 * C3.

The syntax of this function is as follows:

PRODUCT(number1, [number2], [number3], [number4],...)

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The syntax used for the PRODUCT function relates with the following arguments:

- `number1` – It is mandatorily required. The first number or range that you want to multiply.
- `number2`, `3`, `4` – They are optional. Additional numbers or ranges to multiply, up to a maximum of 255 arguments.

This function realizes only numbers in an array or reference for calculations and they got multiplied. The empty excel cells, or containing logical or text values are ignored for calculation.

The data as mentioned in the spreadsheet is - 3,6,9,12. The following table distinguishes between various ways to multiply cells.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>=PRODUCT(A1:A4)</td>
<td>Multiplies the numbers in cells from A1 through A4.</td>
<td>1944</td>
</tr>
<tr>
<td>=PRODUCT(A1:A4, 2)</td>
<td>Multiplies the numbers in cells from A1 through A4, and then multiplies that particular result by 2.</td>
<td>3888</td>
</tr>
<tr>
<td>=A1<em>A2</em>A3*A4</td>
<td>Multiplies the numbers in cells from A1 through A4 by using mathematical operator (*) instead of the PRODUCT function.</td>
<td>1944</td>
</tr>
</tbody>
</table>

**MOD () function:**

This function returns the remainder of a number once the provided number is divided by another number as divisor. The result has the same sign as divisor.
Syntax – MOD (number, divisor)

Number (Required) - The number for which you want to find the remainder.
Divisor (Required) - The number by which you want to divide number.

While using this function you need to keep in mind that if the divisor is “0”, it returns the #DIV/0! Error. The MOD function can be expressed in terms of the INT function:

\[
\text{MOD}(n, d) = n - d \times \text{INT}(n/d)
\]

As described in above figure, function mod (A1,A2) returns the remainder in cell A3 where A1 is 369, A2 is 6 and finally the output of this function is remainder of 369 divided by 6 as 3.

Following table shows details of various permutations used amongst number and divisor to be provided to the function mod ()

<table>
<thead>
<tr>
<th>Number</th>
<th>Divisor</th>
<th>=mod(number, divisor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>369</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>369</td>
<td>-6</td>
<td>-3</td>
</tr>
<tr>
<td>-369</td>
<td>-6</td>
<td>-3</td>
</tr>
<tr>
<td>-369</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

SUMIF:

You use the SUMIF function to sum the values and it meets the criteria that you specify. For example, suppose that there is a column that contains numbers, and you want to sum only the values that are less than 3. The following formula can be used:
=SUMIF(B1:B15,"<3") results in 12

This formula results in adding those numbers out of the list which are less than the defined parameter in the formula bar i.e. "<3"

In the following example, this criterion is applied to the same values that are being summed. If there is a need, then you can apply the criteria to one range and sum the corresponding values in a different range. For example, the formula =SUMIF(A1:A5, "Jack", B1:B5) sums just the set of values provided
in the range B1:B5, once the matching cells in the provided range A1:A5 equal "Jack."

**Fig. 17.26: SUMIF Criterion**

**MMULT:**

Now to make it understand better, we shall discuss a matrix multiplication for products like Spoon, Fork and Cup with certain attributes like Price and Weight purchased by customers like Big Bazaar and Easy Day.

**Fig. 17.27: Matrices**
The first matrix describes products and customer going to purchase them, second matrix showcase the attributes of the products in the form of product price and its weight. Finally, the third matrix where computation with MMULT (Array1, Array2) taken place with matrix formula.
Check Your Progress A

1) What do you understand by Array Formulas?

2) Give some examples of financial functions.
3) “OR” is a type of ……………………
   a) Financial function
   b) Logical function
   c) Text function
   d) Date & Time function

4) Choose a TEXT Function from below options:
   a) VLOOKUP
   b) SUM
   c) CONCATENATE
   d) PMT

5) What is the usage of “MMULT” formula?

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17.5 STATISTICAL FUNCTIONS

AVERAGE
The average() function results in the arithmetic mean of the numbers entered as arguments to the function eg. A2:A10 holds the values in numbers than the formula =AVERAGE(A2:A10) provides the average of the given numbers.

For example, the marks secured by 5 students out of 20 are mentioned below, now for calculating average of the same is calculated by [=average(B2:B6)] which results in 13.8

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Marks [20]</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arun</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Amit</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Ashu</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Aslam</td>
<td>15</td>
<td>Average(B2:B6)</td>
</tr>
<tr>
<td>Akash</td>
<td>13</td>
<td>13.8</td>
</tr>
</tbody>
</table>

COUNT
The count() function works as it spells, it counts the number of arguments passed as range to the function.
For example, the number of items mentioned in the range for count() provides the count of items in that range \[=\text{count}(B:B6)\] results in 5.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Marks [20]</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arun</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Amit</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Ashu</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Aslam</td>
<td>15</td>
<td>Count(B2:B6)</td>
</tr>
<tr>
<td>Akash</td>
<td>13</td>
<td>5</td>
</tr>
</tbody>
</table>

**COUNTIF**

The countif() function works as it spells, it counts the number of arguments passed as range as per the criteria along with to the function.

For example the number of items mentioned in the range for count() provides the count of items in that range \[=\text{countif}(B:B6,">13")\] results in 3, as it counts only those values which are more than 13 as the logical operator applied in criteria i.e. “>13”.

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Marks [20]</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arun</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Amit</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Ashu</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Aslam</td>
<td>15</td>
<td>Countif(B2:B6,&quot;&gt;13&quot;)</td>
</tr>
<tr>
<td>Akash</td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

**FREQUENCY**

The frequency() function is an array based function, it works as it spells, it counts the number of arguments passed as range as per the criteria along with to the function.

For example, the number of items mentioned in the range for frequency() provides the count of items in data_array arguments as bins_array. 
\[=\text{frequency}(\text{data\_array}, \text{bins\_array})\]

The count of items upto the number mentioned in bins_array is reflected as outcome of the function. For example, you can find 2 numbers from 0 to 15 in the list of data_array and 1 from 15 to 20, whereas 5 numbers from 20 to 30.
Table 17.6: Dataset for FREQUENCY

<table>
<thead>
<tr>
<th>Marks</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

MAX, MIN

These two functions are providing the maximum or minimum out of the range of input values.

Maximum number can be derived as outcome of =max(range) function.

Minimum number can be derived as outcome of =min(range) function.

Table 17.7: Dataset for MAX, MIN

<table>
<thead>
<tr>
<th>Name</th>
<th>Marks [50]</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arun</td>
<td>35</td>
<td>Maximum</td>
</tr>
<tr>
<td>Akash</td>
<td>32</td>
<td>=max(b2:b16)</td>
</tr>
<tr>
<td>Aslam</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>Amit</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Ashu</td>
<td>21</td>
<td>Minimum</td>
</tr>
<tr>
<td>Akbar</td>
<td>15</td>
<td>=min(b2:b16)</td>
</tr>
<tr>
<td>Aisha</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Aruna</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Ananya</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Anvita</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Ashi</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Ashok</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Asha</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Ashna</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Advita</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
17.6 FINANCIAL FUNCTIONS

PMT

This function calculates the amount to be paid against a loan calculated on fixed number of payments and a rate of interest. This function has got following syntax:

\[ \text{PMT}(\text{Rate}, \text{Nper}, \text{Pv}, [\text{Fv}], [\text{Type}]) \]

- **Rate** (required): Signifies rate of interest for the loan.
- **Nper** (required): Signifies the number of payments for the loan.
- **Pv** (required): The present value for a series of future payments worth currently (principal amount).
- **Fv** (optional): The future value to attain after the last payment is made. It is assumed to be 0 (zero) if omitted.
- **Type** (optional): If 0 (zero) than beginning of period or 1 (one) indicates payments are due at end of period.

The outcome of this formula for Rate of 8%, installment to be paid for the loan as 12, and the present value of the future payment known as principal amount is shown in the figure below:

![Fig. 17.31: PMT Function](image)

DB & SLN

Both these functions used for calculating the depreciating value of an asset.

DB function is used to calculate and returns the amount of depreciation against an asset for a defined period using the written down value method, whereas SLN function returns the calculated values using straight line depreciation method of values of an asset for a period, i.e. depreciation amount remains same for every period.
Syntax for DB is DB(cost, salvage, life, period, [month])

**Cost (required):** The buying/purchased cost of the asset.

**Salvage (required):** It defines the value calculated at the end of the depreciation.

**Life (required):** The number of periods over which the asset is being depreciated.

**Period (required):** The time period for which the calculation of the depreciation has been done. Period must use the same units as life.

**Month (optional):** The number of months in the first year. If the month is omitted, it is assumed to be 12.

The written down value method computes depreciation at a fixed rate. DB uses the following formulas to calculate depreciation for a period:

**Cost:** total depreciation calculated from past periods) * rate

where:

rate = 1 - ((salvage / cost) ^ (1 / life)) [calculated till 3 places of decimal]

Depreciation for the first and last periods is a different case. For the first period, DB uses this formula:

(Cost * rate * month) / 12

For the last period, DB uses this formula:

((cost - total depreciation calculated from past periods) * rate * (12 - month)) / 12

![Fig. 17.32: DB Function](image-url)
\[ =DB(100000,10000,6,6) \] generates an outcome of 4,672.25

**FV & NPV**

To calculate the future value of any amount as an investment using fixed interest rate. You can use FV with either periodic, constant payments, or a single lump sum payment.

Syntax for the formula is \( FV(rate, nper, pmt, [pv], [type]) \) has the following arguments:

\[ FV(6\%, 12, -600, -1000, 0) \] generates an outcome of 12,134.16

NPV: This function is used to calculate the net present value of any amount as an investment by providing a discount rate and a set of future payments (to be provided as negative values) and receipt of income generated (to be provided as positive values).

\[ NPV(rate, value1, [value2], ...) \]

The function NPV is dependent over the order of input of values as arguments to calculate the order of cash flows. Only numbers in an array or reference are used.

The formula to calculate NPV for \( n \) number of cash flows in the list of values is given below:

\[ NPV = \sum_{i=1}^{n} \frac{\text{values}_i}{(1 + \text{rate})^i} \]

NPV is similar to the PV function (present value).

NPV is related to the IRR function (internal rate of return). Where IRR reflects the rate of return at which NPV equals zero: \( NPV(\text{IRR}(...), ...) = 0 \)
The below example is provided to better understand the application of “NPV” in MS Excel.

**Table 17.8: Dataset for NPV**

<table>
<thead>
<tr>
<th>Data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Discount rate [Yearly]</td>
</tr>
<tr>
<td>-10000</td>
<td>Initial cost of investment [Yearly]</td>
</tr>
<tr>
<td>3000</td>
<td>Return on investment [1st year]</td>
</tr>
<tr>
<td>4200</td>
<td>Return on investment [2nd year]</td>
</tr>
<tr>
<td>6800</td>
<td>Return on investment [3rd year]</td>
</tr>
</tbody>
</table>

**Formula**

\[
\text{Result} = \text{NPV}(A2, A3, A4, A5, A6) = 1,188.44
\]

**IRR**

It returns the internal rate of return for a series of cash flows represented by the numbers in values. It is not necessary for these cash flows to be even, as required for an annuity. However, the cash flows must occur at regular intervals, like monthly or annually.

**Syntax: IRR(values, [guess])**

Values (required) - An array or a reference to cells that contain numbers for which you want to calculate the internal rate of return. Values must contain at least one positive value and one negative value for the calculation. IRR uses
the order of values to interpret the order of cash flows. If an array or reference argument contains text, logical values, or empty cells, those values are ignored.

Guess (optional) - A number that you guess is close to the result of IRR.

RATE
It returns the annual rate of interest.

Syntax - RATE(nper, pmt, pv, [fv], [type], [guess])

The following table would help us to understand the “RATE” Function better:

<table>
<thead>
<tr>
<th>Data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Years</td>
</tr>
<tr>
<td>-750</td>
<td>EMI</td>
</tr>
<tr>
<td>20000</td>
<td>Loan Amount</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>=RATE(A2*12, A3, A4)</td>
<td>EMI</td>
<td>3.18%</td>
</tr>
<tr>
<td>=RATE(A2*12, A3, A4)*12</td>
<td>Annual rate of interest.</td>
<td>38.10%</td>
</tr>
</tbody>
</table>

YIELD
It returns the yield against an amount as security looking forward to pay interest in a defined period of time.

Syntax: YIELD(settlement, maturity, rate, pr, redemption, frequency, [basis])

Settlement (required): The settlement date for security.
Maturity (required): The maturity date of security.
Rate (required): The annual rate of interest for security.
Pr (required): The face value of security.
Redemption (required): The redemption value of security.
Frequency (required): The number of payments per year.
Basis (optional): The type of day count basis to use.

17.7 LOGICAL FUNCTIONS

Logical functions are the repository to implement the logical relationships amongst cell ranges included in the formula.

IF()
This function performs branching operations during the decision-making. There are 3 arguments passed to this function.

- logical_test (required): for a binary outcome in the form of true or false.
Spreadsheets and Business Applications

- value_if_true (required): branching operation when logical_test return true.
- value_if_false (optional): branching operation when logical_test return false.

Fig. 17.35: IF Function

In above example the customer uses a logical test amongst the prices of commodities to purchase from two different shops. The status reflects the choice of shop for the commodities.

AND

This logical test requires at least 2 input arguments for its functionality, it checks the binary outcome from the conditions placed as arguments in the function TRUE[1] or FALSE[0]. Once all the arguments reflect TRUE [1] as outcome, only then this function provides TRUE [1] as output.

Table 17.10: Dataset for AND

<table>
<thead>
<tr>
<th>Con1</th>
<th>Con2</th>
<th>Con3</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

In above example 3 different conditions with logical inputs are mentioned as Con1, Con2, Con3 and Result is based on logical inputs to the function as
=AND(Cond1, Cond2, Cond3). Once it gets all three conditions TRUE, the result becomes TRUE.

For Example: Using the formula in D11 as relative cell address and copied it in all the other cells in the same column, we can easily mark that whether that entity can Vote in India or not.

=AND(A11>=18,B11="Indian",C11="Active")

**Table 17.11: Dataset 2 for AND**

<table>
<thead>
<tr>
<th>Age</th>
<th>Citizenship</th>
<th>Status</th>
<th>Vote in India</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Indian</td>
<td>Active</td>
<td>FALSE</td>
</tr>
<tr>
<td>18</td>
<td>Indian</td>
<td>Active</td>
<td>TRUE</td>
</tr>
<tr>
<td>25</td>
<td>Not Indian</td>
<td>Active</td>
<td>FALSE</td>
</tr>
<tr>
<td>27</td>
<td>Indian</td>
<td>Inactive</td>
<td>FALSE</td>
</tr>
<tr>
<td>23</td>
<td>Not Indian</td>
<td>Inactive</td>
<td>FALSE</td>
</tr>
<tr>
<td>27</td>
<td>Indian</td>
<td>Active</td>
<td>TRUE</td>
</tr>
<tr>
<td>35</td>
<td>Indian</td>
<td>Active</td>
<td>TRUE</td>
</tr>
<tr>
<td>37</td>
<td>Not Indian</td>
<td>Active</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

**TRUE & FALSE**

These two functions TRUE() and FALSE() returns the logical values TRUE and FALSE respectively and they are used primarily for checking compatibility with other spreadsheets of the workbook.

### 17.8 TEXT AND FORMATTING FUNCTIONS

Text and formatting functions are mostly required for string handling in Excel Datasets.

**LEFT & RIGHT**

These two formulas require two input arguments namely ‘Text’ and ‘Num_chars’ for returning specified number of characters from the beginning or from the last of defined string in the formulas as an argument. If the second argument is not passed then the function returns a character according to the function used. Starting character of the string if Left() function is used and last character if Right() function is used.

=LEFT(Text, Num_chars)

=RIGHT(Text, Num_chars)

For example, the strings mentioned in table below shall be processed depending upon the formula applied over them and outcomes are reflected in third column.
Table 17.12: Dataset for LEFT, RIGHT

<table>
<thead>
<tr>
<th>Input String</th>
<th>Formula</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Talk</td>
<td>=Left(A2,5)</td>
<td>Small</td>
</tr>
<tr>
<td>Small Talk</td>
<td>=Right(A2,4)</td>
<td>Talk</td>
</tr>
<tr>
<td>Small Talk</td>
<td>=Left(A2)</td>
<td>S</td>
</tr>
<tr>
<td>Small Talk</td>
<td>=Right(A2)</td>
<td>k</td>
</tr>
</tbody>
</table>

CLEAN

This function removes all the non-printable characters from the text provided as argument to this function. This text is any information from the worksheet from the removal of non-printable characters is desirable.

CONCATENATE

This function plays an important role while joining various text strings into a single text string. The text strings provided as cell reference to them, or typed with in the function for joining in the outcome of this function.

LOWER & UPPER

These two functions changes the case of the input string to lower or upper case as per use case of the functions according to the requirement.

17.9 DATE AND TIME FUNCTIONS

DATE

This function incorporates three different components from different cell addresses and convert them into a single outcome in the form of a date. As shown in the figure below, date function is collecting attributes from C1 as Year, A1, as Month and B1 as Day and finally shows the Date as 14-02-2019.

![Fig. 17.36: Date Function](image)

DAY

This formula reflects the day of the date provided to the function as outcome of this function. As mentioned in figure below, the date 14-02-2019 is passed
as argument to =Day(A2) the outcome to this function is 14, which is day of the date.

![Excel screenshot showing Day function usage](image)

**Fig. 17.37: Day Function**

**TODAY & NOW**

These two functions work without any arguments in the function. They return the system date for Today() and System Date and Time for Now().

**Check Your Progress B**

1) Write the syntax for DB.

2) Distinguish between COUNT and COUNTIF function.

3) What is Clean function.
4) Write the syntax for RATE.

17.10 LET US SUM UP

Microsoft Excel consists of many powerful formulas and functions, which can be used for various problems, whether it be financial, logical, statistical or mathematical. A Formula, in MS Excel, is an expression, which consists of values, operators and conditions, applied over a cell or a range of cells.

An array is a combination of either a row of values, column of values or both the row and column of values. An array formula can perform multiple no. of calculations on one or more cells of an array. It can give both the single and multiple cell results. They are also known as CSE (Control + Shift + Enter) Formula.

There are different types of functions and formulae in MS Excel, which can be used efficiently for solving problems in Finance and Commerce. It is a very powerful software and is widely regarded as the best available Spreadsheet Tool all over the world. Functions like “IF”, “VLOOKUP” and “CONCATENATE” are vastly utilized in financial jobs and they are the basic requirement of the industry.

A function, in MS Excel, can be termed as a pre-structured or pre-defined formula that can calculate certain results using the selected specific values. A function is based on a certain basic syntax. It includes an equal sign “=”, the name of the function, like SUM, PRODUCT, IF and at last, the argument(s).

Statistical Functions, Financial Functions, Logical Functions, Date & Time Functions, Number & Text Function, Lookup & Reference Functions, Math & Trig Functions etc.
17.11 KEY WORDS

Array Formulas: An array formula is a formula that can perform multiple calculations on one or more items in an array. An array can be as a row or column of values, or a combination of rows and columns of values. Array formulas can return either multiple results, or a single result. They are also known as CSE (Control + Shift + Enter) Formula.

Financial Functions: Financial functions calculate financial information and have been made available to execute a variety of financial calculations such as, payment, present value, calculations of yield, investment valuations, interest rates, internal rate of return, asset depreciation, and payments.

Logical Functions: Logical functions are some of the most popular and useful in Excel. They can test values in other cells and perform actions dependent upon the result of the test. This helps us to automate tasks in our spreadsheets. The functions are AND, OR, XOR and NOT etc.

Mathematical Functions: Mathematical formulas in excel are used to perform various arithmetic operations like adding the values in a range of cells, finding an average of selected cells. The most commonly used mathematical functions in excel are Average, Int, Round, Mod, Rand etc.

Statistical Functions: Statistical functions apply a mathematical process to a group of cells in a worksheet. For example, the SUM function is used to add the values contained in a range of cells. COUNT function to count cell locations with numerical values, AVERAGE function to calculate the arithmetic mean, MAX and MIN functions to find the highest and lowest values in a range of cells.

Text Functions: The Excel text Function is used to convert numbers to text within a spreadsheet. Text is available in all versions of Excel. We use this function in the circumstances; when we want to display dates in a specified format, when we wish to display numbers in a specified format or in a more legible way or When we wish to combine numbers with text or characters.

17.12 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress A

3) b) Logical function

4) c) CONCATENATE
17.13 TERMINAL QUESTIONS

1) What is the key combination used to find the result for an Array Formula? Why is it used?

2) Define Functions in MS Excel.

3) Name the formula categories shown under the Formulas Tab in MS Excel.

4) Why does the “#VALUE!” error come up when adding or subtracting the cells in MS Excel?

5) What is the difference between PV and NPV formulae in MS Excel?

**Note:** These questions are helpful to understand this unit. Do efforts for writing the answer of these questions but do not send your answer to university. It is only for yours practice.