

MATHEMATICAL FUNCTIONS IN SCIENTIFIC CALCULATOR

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I. INTRODUCTION

This article assesses how to recognize a scientific calculator, what each key possesses and how to get the accurate value in any form of the mathematical function. The proper understanding of applying the operations in the calculator that performs the function, in the order we instruct. scientific calculator differs a lot from other basic calculators. The basic calculator ignores the order of operations. The main purpose of the scientific calculator has the function that we need to perform the calculation in chemistry, physics, engineering, or trigonometric problems. It has a significant role when the function is being worked with scientific notation. However, the calculator model used here for referring is *Casio fx-991 ES Plus*. If you are using a different calculator, you should use the corresponding features.

II. START TO KNOW YOUR CALCULATOR

Firstly, we should know how to use the calculator knowing some of the main keys sequences for understanding the basic function, to know what may go wrong when entering the data and calculations, and should know how to fix the calculator functions to a range of mathematical calculations. Secondly, make sure that you are aware of the layout of keys on the keypad and how the details are being displayed on the screen.

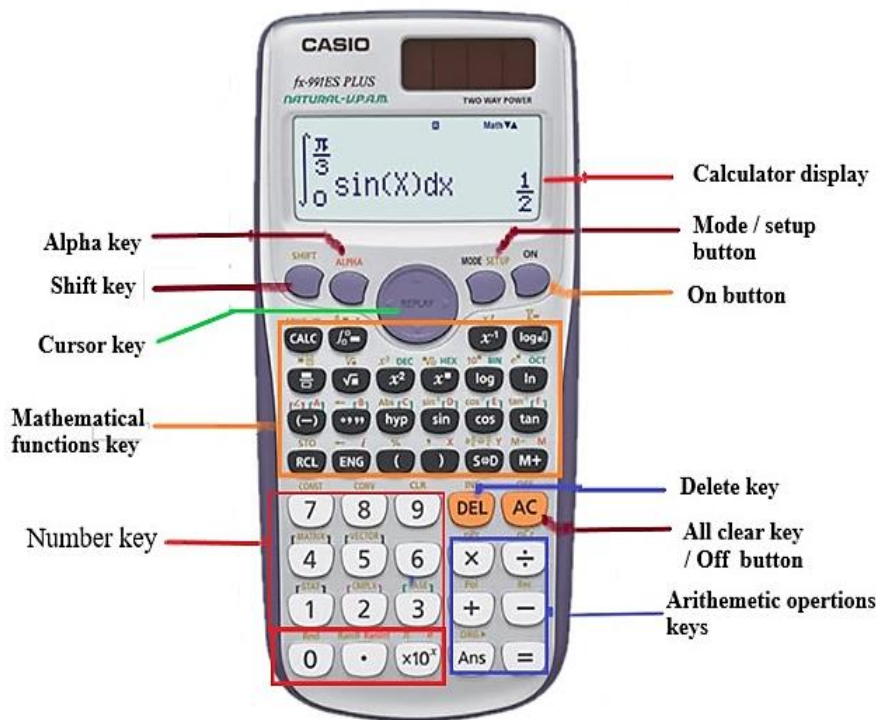


Figure- 2.1 Different parts of the Casio fx-991ES Plus.

If you are using a different model of a scientific calculator you may find similar identical keys and its function in it. To switch on the calculator using the **ON** key. Most of the keys have two or more functions, for example, the main function will be on the button and the second function, an alternate function which will be printed above the button in yellow that can be approached by pressing the **SHIFT** key, and the third function will be printed in red by pressing the **ALPHA** key before selecting the appropriate key. To off the calculator, press **SHIFT AC (OFF)**. The second function of the **AC** key is accessed by the **SHIFT** key that will off the calculator.

III. FUNCTIONS

The following table is a list of common mathematical functions and what they define:

<u>OPERATOR SYMBOLS</u>	<u>MATHEMATICAL FUNCTIONS</u>
+ , - , x , ÷	Arithmetic operators for basic calculations
()	Brackets / parenthesis
x^{\square}	X raised to the power
$\sqrt{\quad}$ or sqrt	Square root
e^x	Exponent raised to the power x
Sin, cos, tan	Trigonometric function
Sin^{-1} , cos^{-1} , tan^{-1}	Inverse trigonometric functions
M+	Add value to that in the 'M' memory
log	Logarithm to the base 10
\log_{\square} \square	Logarithm function
ln	Natural logarithm
calc	Add value to that in the 'M' memory
Ans	Use the result of the previous calculation
hyp	Hyperbolic function
S ↔ D	Improper fraction to mixed fraction / Decimal to fractions
o ‘ ‘	Time calculation
x^{-1}	X is raised to the power minus 1
RCL	The RECALL: Display the value stored in the 'M' memory
STO	Store a value in 'M' memory
ENG	Engineering mode
$X 10^x$	Scientific notations

IV. PROCEDURES

1. CALCULATOR MODE

1:COMP	2:CMPLX
3:STAT	4:BASE-N
5:EQN	6:MATRIX
7:TABLE	8:VECTOR

➤ Mode – COMP

FUNDAMENTAL CALCULATION USING BODMAS:

In this mode, general calculations can be done ‘**MODE**’ ‘**1**’. The calculator follows BODMAS, so it will perform the calculation in the order we instruct. According to the BODMAS rule, if an expression contains a bracket followed by order i.e, powers and roots, then division, multiplication, addition, and subtraction from left to right. Solving the problem in the wrong order will result in incorrect answers. The basic calculation which includes fractions, negative number, and exponent. The negative numbers can be performed by using (-) **key** before the required numbers. The ‘-’ **key** is used for the operation of subtraction but in some calculator allows both purposes.

If you enter a wrong sequential order, the calculator will display it as an error. There are two types of error:

- * ‘**Math Error**’, when the calculation you entered makes mathematical sense but the result cannot be calculated, such as attempting to divide by zero, or when the result is too large for the calculator to handle.
- * ‘**Syntax Error**’, when the calculation you entered that may not make mathematical sense.

Syntax ERROR	Math
[AC] : Cancel	
[←][→] : Goto	

To correct those errors, we have editing facilities by pressing those sides cursors and placing the editing cursor at the point of the error and do the correction to be made.

➤ Mode-CMPLX

In this mode complex number calculations can be performed '**MODE**' '**2**'. Operations can be carried out using an imaginary part '**i**' by pressing '**SHIFT**' '**ENG**' to get the imaginary part.

i. ARGUMENTS:

By pressing '**SHIFT**' '**2**' '**1**'(arguments), enter the required complex number and press '**=**' (**equal to**) key to get the answer.

ii. VALUE OF r AND θ

By entering the required complex number and then press '**SHIFT**' '**2**' '**3**'($r < \theta$) '**=**' (**equal to**) key to get the answer.

iii. CONJUGATE:

By pressing '**SHIFT**' '**2**' '**2**'(Conjugate), enter the required complex number and press '**=**' (**equal to**) key to get the answer.

iv. COMPLEX NUMBER FROM r AND θ :

By entering the required $r < \theta$, then press '**SHIFT**' '**2**' '**3**'($a+ib$) '**=**' (**equal to**) key to get the complex number.

➤ Mode- STAT

This mode, '**MODE**' '**3**'(**STAT**) allows us to input data in multiple forms and will give you the procedures required to calculate many values from the data sets.

1: 1-VAR	2: A+BX
3: $_+CX^2$	4: $\ln X$
5: θ^X	6: $A \cdot B^X$
7: $A \cdot X^B$	8: $1/X$

SINGLE VARIABLE

Compute and on pressing '**SHIFT**' '**1**' interrupt the mean, median, standard deviation, and normal distribution and entering our data one by one on our calculator by pressing '**MODE**' '**3**' '**2**', where only one X variable is used.

Application: Single-variable statistical calculations are used in a broad range of fields, including engineering, business, and economics. They are most often applied to analysis in atmospheric observations and physics experiments, as well as for quality control in factories.

1:Type	2:Data
3:Sum	4:Var
5:Distr	6:MinMax

3:Sum:

1:Σx ²	2:Σx
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5:Distr:

1:P(2:Q(
3:R(4:▸t

REGRESSION AND CORRELATION

$y=A+Bx$ is the estimated regression line of Y on X.

Correlation can reveal how strongly two variables are related. This can be done by obtaining the coefficient correlation, r . The coefficient correlation, r is a measure of the linear relationship between pair of variables x and y . the value of r will be between -1 to 1.

By pressing '**MODE**' '**3**' '**2**', enter the data one by one for the variables x and y respectively. Interrupt the mean, median, standard deviation, r , minimum and maximum values, a (intercepts) and b (reg-coefficient), on pressing '**SHIFT**' '**1**'.

1:Type	2:Data
3:Sum	4:Var
5:Reg	6:MinMax

3:Sum

1:Σx ²	2:Σx
3:Σy ²	4:Σy
5:Σxy	6:Σx ³
7:Σx ² y	8:Σx ⁴

4:Var:

1:n	2: \bar{x}
3:0x	4:sx
5: \bar{y}	6:0y
7:sy	

5:Reg:

1:A	2:B
3:r	4: \bar{x}
5: \bar{y}	

6: 1:minX: 2:maxX:

3:minY: 4:maxY:

1:minX	2:maxX
3:minY	4:maxY

➤ Mode- BASE-N

The Mode BASE-N, '**MODE**' '4', will change the number base between the many number modes available. Changing the Mode alters the legends on buttons that have functions specific to different number modes. Changing number mode changes the calculator display, but any data stored in the calculator is retained. Conversion between different number systems by entering data and then selecting the new number base. However, only the decimal system has a decimal point, the other number bases work for integers only. Also note that a number in one system will require a larger number of digits in a lower number base, which may cause an overflow. This is especially likely when converting to binary. To change the conversion press '**SHIFT**' '3' for having **and**, **or**, **xor**, **xnor**, **not** and **neg**.

➤ Mode- EQN

Solving equations for x is possible in this mode, '**MODE**' '5'. The quadratic equation is solved easily using the quadratic formula for finding the value of X, which is stored in the calculator.

The roots of the equation will be calculated and will be displayed on the screen as X_1 and X_2 .

The calculator allows the equations for x which have complex numbers as their roots.

By pressing '**MODE**' '**5**', will be changed to equation mode, you will be presented with the following options:

1: $a_n X + b_n Y = c_n$

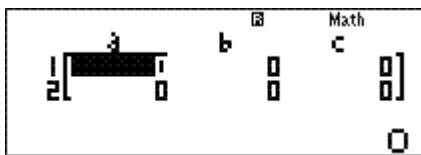
2: $a_n X + b_n Y + c_n Z = d_n$

3: $aX^2 + bX + c = 0$

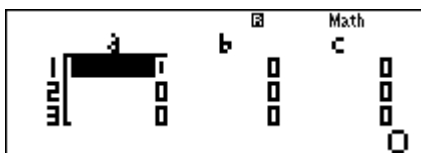
4: $aX^3 + bX^2 + cX + d = 0$

Enter the values of a , b , c respectively, and press '=' to solve the equation for X .

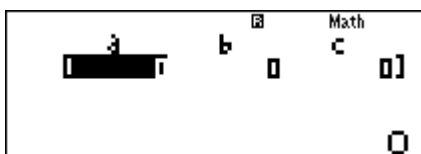
1: System of equations with two unknowns:



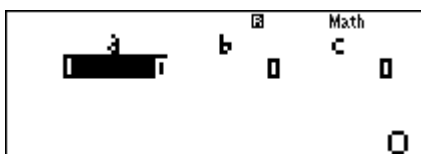
2: System of equations with three unknowns:



3: Quadratic equation:



4: Cubic equation:



➤ **Mode-MATRIX**

To do matrix addition or subtraction or to find matrices multiplications can be easily done in the scientific calculator by matrix mode '**MODE**' '**6**' '**1**' (Mat A), select your dimension (m × n) and enter your data. Matrices can be carried out matrices up to 3 × 3. To perform the matrices calculation, we must give special variables (Mat A, Mat B, Mat C), which will be used then a variable in the calculations.

NOTE: '**Mat ANS**' stands for matrix answer memory.

MatA(mxn) mxn?	
1:3x3	2:3x2
3:3x1	4:2x3
5:2x2	6:2x1

i. DETRERMINANENT

Go to the matrix option by pressing '**SHIFT**' '**4**' '**7**' (DET)and choose the matrix you assign '**SHIFT**' '**4**' '**3**' (Mat A) and then press '=' to get the answer.

MAT	
det(MatA)	
-69	

ii. TRANSPOSE

Go to the matrix option by pressing '**SHIFT**' '**4**' '**8**' (Trn)and choose the matrix you assign '**SHIFT**' '**4**' '**3**' (Mat A) and then press '=' to get the answer.

MAT	
Trn(MatA)	
0	

iii. INVERSE

Choose the matrix you assign '**SHIFT**' '**4**' '**3**' (Mat A), press **X⁻¹** then press '=' to get the inverse matrix.

iv. ABSOLUTE VALUE OF A MATRIX

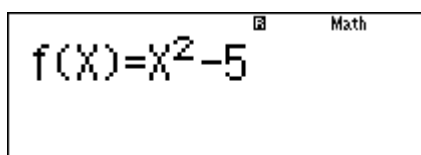
We can obtain the absolute value of a matrix by pressing '**SHIFT**' '**HYP**' (Abs), choose the matrix you assign '**SHIFT**' '**4**' '**3**' (Mat A) and then press '=' to get the answer

v. MATRIX MULTIPLICATIONS

Go to the matrix option by pressing '**SHIFT**' '**4**' and choose the matrix you assign '**SHIFT**' '**4**' '**3**' (Mat A), then press '**X**' (multiplication option), select Mat B '**SHIFT**' '**4**' '**4**' and then press '=' to get the answer.

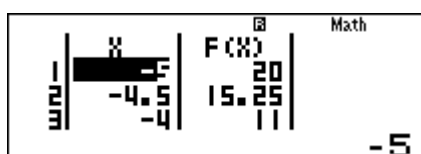
➤ Mode- TABLE

This mode '**MODE**' '**7**' provides you with a table of values. This mode helps us to find the value of a function (y) at each given value of the variable (x). type the equation of the function into the f(x)= (input field) and press the '=' button. Table Mode shares the same set of functions with Graph Mode within a single workspace.



The image shows a calculator screen in Math mode. The input field contains the equation $f(X) = X^2 - 5$. The screen also shows a small icon of a table and the word "Math" in the top right corner.

Now, by Entering the value of X at which the table should begin and end, the difference between each value and the table can be generated using its function.

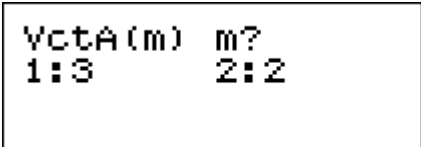


The image shows a calculator screen in Math mode displaying a table of values for the function $f(X) = X^2 - 5$. The table has two columns: X and F(X). The X values are 2, -4, and -4. The F(X) values are 20, 15, and 25. The screen also shows a small icon of a table and the word "Math" in the top right corner. The value -5 is shown at the bottom right of the screen.

X	F(X)
2	20
-4	15
-4	25

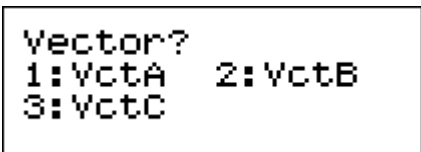
➤ Mode- VECTOR

This mode '**MODE**' '**8**' carries out the calculation on 2D and 3D vectors. Selecting vector mode, we must give data to choose a vector memory slot (Vct A, Vct B, Vct C), which will be used then as a variable in the calculation, we'll be prompt to choose the dimension of the vector(2 or 3).



VctA(m) m?
1:3 2:2

To enter data for another vector press **'SHIFT' '5'**(VECTOR), which will be now called a vector option, and choose **'2'** (DATA). Proceed by choosing a different memory slot(Vct B, Vct C)



Vector?
1:VctA 2:VctB
3:VctC

✓ CROSS PRODUCT

Go into vector option by pressing **'SHIFT' '5'** and choose the vector you assign your data **'3'**(Vct A) to show up on the main screen and press **'X'**(multiplication option), select another vector Vct B, **'SHIFT' '5' '4'** and finally **'='** to get the answer.

✓ DOT PRODUCT

Select vector A (Vct A) **'SHIFT' '5' '3'** and re-enter into the vector option **'SHIFT' '5'** and select **'7'**(DOT), go to vector option again select vector B (Vct B), press **'='** to get the answer.

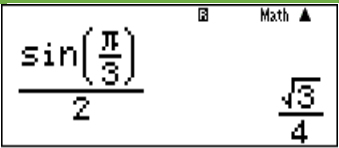
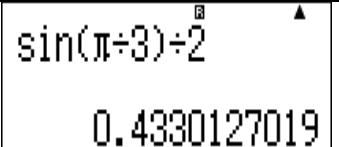
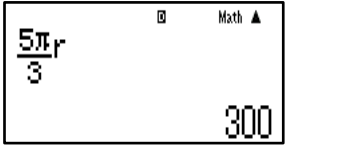
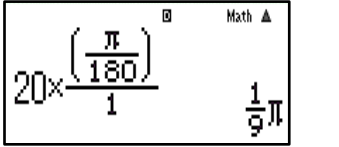
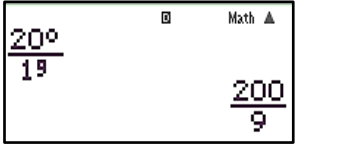

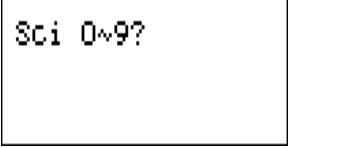


VctA · VctC
18

✓ MAGNITUDE OF A VECTOR

Choose your vector by entering to vector option and then press **'SHIFT' 'HYP'**(Abs) and finally press **'='** to get the magnitude of a vector A, **|A|**.

➤ SETUP – ('SHIFT' 'MODE')

<u>SET UP</u>	<u>MATHEMATICAL FUNCTION</u>	<u>PROCEDURE</u>	<u>EXAMPLE</u>
MthIO	The answers will have a natural display in the form of fractions	'SHIFT' 'MODE' '1'	
LineIO	It will be displayed in a linear form as decimals	'SHIFT' 'MODE' '2'	
Deg	Specify degrees as the angle unit	'SHIFT' 'MODE' '3'	
Rad	Specify radians as the angle unit	'SHIFT' 'MODE' '4'	
Gra	Specify grads as the angle unit	'SHIFT' 'MODE' '5'	
Fix	Control the number of decimal places in the results that we obtain	'SHIFT' 'MODE' '6'	
Sci	Control the number of significant digits in the results that we obtain	'SHIFT' 'MODE' '7'	

Norm	Non-exponential form in the specified range	'SHIFT' 'MODE' '8'	
ab/c	set the calculator to use mixed numbers by default,	'SHIFT' 'MODE' '▼' '1'	
d/c	set the calculator to use improper or top-heavy fractions by default	'SHIFT' 'MODE' '▼' '2'	

V. MATHEMATICAL FUNCTIONAL KEYS

➤ **PERCENTAGE:**

A percentage is a number, or a ratio expressed in a fraction of 100. Input the value using the number pad and press **'SHIFT' '('**, the percentage sign should appear on the screen and press **'=**' to get the required answer.

➤ **FACTORIAL:**

The factorial of a positive integer of n is denoted by n! it's a product of all positive integer less than or equal to n. To find the factorial of a scientific calculator, enter any value and press **'SHIFT' 'X!'** and press **'=**' to get the required answer.

Application: Used in statistics and mathematics. In statistics, this function is used in calculations involving combinations and permutations

➤ **SUMMATION:**

The summation is the addition of a sequence of any kind of numbers called summands, the result is their sum.

In the scientific calculator, find the summation of natural numbers 1 to 10. Press the **'SHIFT'** button, then **'log_□ □'** the summation sign, $\sum_{x=□}^n □$ will be displayed on the screen. Input the function in terms of X and enter the value for x and value for n.

➤ **INTEGRATION and DIFFERENTIATION:**

It can be calculated with respect to x. Integration can be performed by pressing the button **'∫_□[□] □'** a button from your calculator. It will display the integration symbol with upper and lower limits and the integrand and dx at the end. To perform integration, enter your integrand equations in terms of x and enter your limits and press **'='** to display your answer.

To perform differentiation, press $\frac{d}{dx} □$. Enter the equation to be differentiated in terms of x and enter the value for x in which you want to find the value for the gradient, press **'='** to get the required answer.

➤ **TRIGONOMETRIC FUNCTION VALUE:**

To find the values of the trigonometric ratios of angles you need to ensure that various units in which an angle can be measured, in degrees or radians. To calculate the trigonometric values using the sine, cosine, or tangent of an angle, press the **'SIN'** **'COS'** or **'TAN'** key and then type the measurement of an angle. after entering the angle press **'='** to get the trigonometric value.

Application: Trigonometric functions are useful in mathematics and various engineering calculations. They are often used in astronomical observations, civil engineering, and in calculations involving electrical circuits, as well as in calculations for physics such as parabolic motion and wave motion.

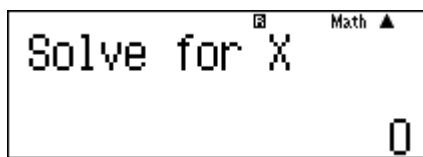
➤ **INVERSE TRIGONOMETRIC VALUE:**

Finding angles from trigonometric ratios, we can be obtained by taking inverse trigonometric functions. To calculate inverse trigonometric values can be found using the second

functions \sin^{-1} , \cos^{-1} and \tan^{-1} , by pressing '**SHIFT**' '**SIN**', '**COS**', or '**TAN**' to get the required angle.

➤ EQUATION SOLVE:

The equation for X is possible with the functionality of '**SHIFT-solve**' when a quadratic equation which is not in their standard forms or any equations. The calculator finds the value for x by using the Newton- Raphson method. It only allows the equation to have a single variable. Type the equation and press '**SHIFT**' '**CAIC**' (**SOLVE**), to solve for x.



➤ PERMUTATION and COMBINATION:

1. **nPr**: This function finds the number of different possible orderings in selecting r objects from a set of n objects. Input the number, n, and press '**SHIFT**' '**X**' (**MULTIPLICATION SIGN**), the letter P will be displayed which indicates for permutation and input the value for r and then finally press '**=**' to get the answer.
2. **nCr**: This function finds the number of ways of selecting r objects from a set of n objects. Input the number, n, and press '**SHIFT**' '**÷**' (**DIVISION SIGN**), the letter C will be displayed which indicates for combination and input the value for r and then finally press '**=**' to get the answer.

Applications: Used to find the expansion of polynomial, also used in statistics (probability calculations) and simulation hypotheses in fields such as medicine, pharmaceuticals, and physics. Also, can be used to determine the chances of winning in lotteries.

➤ LOGARITHM, NATURAL LOGARITHM, and e POWER X:

1. LOGARITHM:

'log' button in your calculator will calculate the logarithm, the exponent of the power to which 10 must be raised to equal the given value. By pressing the 'log' button and enter any value, press '=' to get the log value of that number.

'log_□ □' button in your calculator will calculate the logarithm in which the base can be entered that must be raised to the given value.

2. NATURAL LOGARITHM

'ln' button computes the value of the natural logarithm, the exponent of the power to which e must be raised to equal the given value.

3. e POWER X

By pressing the 'SHIFT' 'ln' button or by pressing 'ALPHA' '× 10^x' 'x[□]' so that $e^□$ will be displayed on the screen. Here it calculates powers based on the constant e (2.718281828).

4. 10 TO THE POWER of X


'× 10^x' button calculates the value of 10 raised to the power x

➤ TIME CALCULATION:



Inputs values in sexagesimal notation (degrees, minutes, seconds). You must input zero even the degree or minute value is zero.

Application: Used in calculations of angles and angular velocity in physics, and latitude and longitude in geography.

➤ FRACTION and DECIMALS:

Fractions are entered using the  button in the left-hand column of the function key area.

Mixed numbers can be entered similarly using the mixed number template obtained using the key

sequence 'SHIFT'  () or by entering our fraction and press 'SHIFT' 'S↔D' to get a

mixed fraction. Conversion of a fraction to decimal can be done by entering a fraction and press

'S↔D' to get the respective decimal answer.

By pressing '**SHIFT**' '**MODE**'(SETUP) '**▼**' '**5**' Specify the decimal point for calculation results.

Decimal Point?	
1:Dot	2:Comma

Application: There is a wide variety of applications for this function because fractions are such a basic part of mathematics. This function is useful for calculations involving electrical circuit resistance.

➤ **HYPERBOLIC FUNCTION:**

The hyperbolic function is defined by using natural exponents in trigonometric functions.

Arc hyperbolic functions are defined by using natural logarithms in trigonometric functions

1:sinh	2:cosh
3:tanh	4:sinh ⁻¹
5:cosh ⁻¹	6:tanh ⁻¹

Applications: Hyperbolic and arc hyperbolic functions are very useful in electrical engineering and physics.

➤ **ABSOLUTE VALUE:**

To the absolute value of any number or a function can be done, by pressing '**SHIFT**' '**HYP**' (Abs) and entering the function or any number to get the required answer.

➤ **IMPORTANT SCIENTIFIC CONSTANT**

A scientific constant that can be used inside of calculation by pressing Shift then 7 in any mode except Base-N, it is possible to recall one of 40 constants stored on the calculator by inputting a number from 01 to 40. Some important scientific constants are

Press '**SHIFT**' '**7**' (CONSTANT 01 – 40)

```
CONSTANT
Number 01~40?
      [  _ ]
```

01 - Mass of proton

02 - Mass of neutron

03 - Mass of electron

06 - Planck's constant

17 - Atomic mass unit

24 - Avogadro's constant

27 - Molar gas constant

28 - Speed of light

35 - Gravitational field strength

38 - Difference between Kelvin and Celsius

39 - Gravitational Constant

40 - Atmospheric pressure

➤ CONVERSION OF UNITS

Conversion of units from one unit to another can be easily done in the scientific calculator by

inputting the value that is to be converted and press **'SHIFT' '7'** (CONSTANT 01 – 40)

```
CONVERSION
Number 01~40?
      [  _ ]
```

01: in ► cm	02: cm ► in	03: ft ► m	04: m ► ft
05: yd ► m	06: m ► yd	07: mile ► km	08: km ► mile
09: n mile ► m	10: m ► n mile	11: acre ► m ²	12: m ² ► acre
13: gal (US) ► ℓ	14: ℓ ► gal (US)	15: gal (UK) ► ℓ	16: ℓ ► gal (UK)
17: pc ► km	18: km ► pc	19: km/h ► m/s	20: m/s ► km/h
21: oz ► g	22: g ► oz	23: lb ► kg	24: kg ► lb
25: atm ► Pa	26: Pa ► atm	27: mmHg ► Pa	28: Pa ► mmHg
29: hp ► kW	30: kW ► hp	31: kgf/cm ² ► Pa	32: Pa ► kgf/cm ²
33: kgf • m ► J	34: J ► kgf • m	35: lbf/in ² ► kPa	36: kPa ► lbf/in ²
37: °F ► °C	38: °C ► °F	39: J ► cal	40: cal ► J

Conversion formula data is based on the "NIST Special Publication 811 (1995)".

Note: The J ► cal command performs conversion for values at a temperature of 15°C.

➤ POWERS AND SURDS

1. Taking the Power:

enter any number and press **x[□]**, input to which power has to be calculated. To get any number to be squared press **x²** and similarly for any number to be powered by a cube press '**SHIFT**' '**x³**'.

2. SURDS:

roots of any number can also be found directly. Square roots can be calculated using the button **√** and similarly to get any root of any number press '**SHIFT**' '**x[□]**' to display (**√[□]**), which is the second function of the key '**x[□]**'.

3. Π- Pi:

'**π**' is used for scientific calculation. You could enter an approximate value for π by hand, but this is time-consuming and won't be accurate and leads to error. The calculator has an approximation value for π built into it, which is obtained using the key sequence '**SHIFT**' '**× 10^X**' (**π**).

➤ CALCULATOR MEMORY:

To store the result of an expression just calculated (i.e. an answer displayed in the output area of the calculator screen) in the 'M' calculator memory, use the key 'M+'. After selecting the store function, we need to tell the calculator which memory the value is to be stored in. These memories are labelled in red on some of the calculator keys. Once 'RCL' (or 'SHIFT' 'RCL'(STO)) has been pressed, the display indicator RCL (or STO) is shown on the display to indicate that the calculator is waiting to know which memory to recall (*store*) the value.

VI. CONCLUSION

In the above article, we understood the importance and realise how powerful this unassuming scientific calculator actually is. It most sophisticated and comprehensive scientific calculator with an equation solver and are widely used in both education and professional settings.