

TECHCALC - HELP

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GENERAL

Use the menu to change calculator modes (scroll to view all) - the action bar can be hidden via the 'Settings' if required.

Some buttons have 2 values - short press gives main function, long press gives secondary function (in yellow).

A wide variety of themes are available in the following categories:

- **Standard Themes:** Standard 1 is the default used by the application. Some of the standard themes can also use 3D buttons by enabling the '3D Button Effect' choice in the 'Settings'.
- **Monochrome Themes:** these themes use a single color for both the buttons and the background. This color is maintained

throughout the application. A complementary color is used for some of the labels and titles.

- **Custom Theme:** a theme with a personal color scheme can be created by checking the 'Custom Theme' box in the 'Settings' and then choosing 'Edit Custom Theme'. If the color chosen is the same for all of the buttons and the background, the application will be styled as a monochrome theme, otherwise it will be styled as a standard theme.

The text size of the output screens can be increased or decreased by long pressing either the + or – buttons respectively.

The default screen orientation is portrait mode - this can be changed to landscape mode if required in the menu's 'Settings' tab via 'Screen Orientation'. Alternatively, automatic rotation can be enabled in the Settings but the device itself must also have automatic rotation enabled.

Mixed calculations (fractions and decimals) can be made when in SCI mode - see the Fractions Mode tab in the Help section for details of how to enter fractions (in this case, a vertical bar ($\frac{\Box}{\Box}$) is used to substitute the a^b/c button).

In SCI mode, long press a function ("Func" button) to see details of that function.

In SCI mode, the lists for the "Conv" button can be manually rearranged using drag and drop. Long press on a list item and drag it up or down to the desired position. To reset a list back to its default configuration, please press the "Reset List" button. If you want to manually rearrange an alphabetically sorted list, please enable alphabetical sorting before manually rearranging the list.

In Financial mode, calculations, using operators (+, –, × or ÷), can be entered in most fields, if required, except the fields for interest and cash flow.

Please take note of the specific use of the following buttons found on some or all screens:

- **+/-** : used to create negative numbers - if no number is present, a leading minus sign will be entered whilst, if a number (or expression in closed brackets) is present, the sign of the number or bracketed expression will be changed - in HEX/OCT/BIN mode, input the number first then press this button; if pressed again will convert the number back to a positive number.
- **AC** : - means 'All Clear' - clears the entire contents of the calculation.
- **DEL** : - means 'delete to the left' - allows step-by-step rollback of an expression - when in Financial mode, touch the area of the screen for the field that you want to change.
- **ANS** : - to insert the previous result of a calculation anywhere into a new calculation, long press this button (if long pressed immediately after pressing the "=" button, the result of the calculation will be copied to the clipboard). Simple recursive expressions can be evaluated - e.g. to create a sequence that starts at 7 and whose rule is "add 2", enter 7 + 2 and then press the "=" button repeatedly (the results are not added to the history). More complex recursive expressions can be evaluated by including at least one instance of the ANS button in the expression and then pressing the "=" button repeatedly (in this case, the results are added to the history). If required, there is an option in the Settings to "Disable Repetitive Use of = Button".
- **EXP** : - allows large or small numbers to be added in the format number × 10 raised to an index - first enter the number then press the EXP button, then enter the index (integer values only) - negative indices can be entered by first entering the index then pressing the +/- button.
- **%** : - means 'Percentage' - enter the number then press this key - please note how this works: e.g. $80 \times 4\%$ will equal 3.2, while $80 + 4\%$ will equal 83.2 - i.e. 4% of 80 is calculated and then added to 80 (i.e. $80 \times 4\% = 4\% \times 80$, but $80 + 4\% \neq 4\% + 80 = 80 \times 1.04$). However, if the user requires it, there is an option in the settings, "% Button - App treats all operators the same" which, if enabled, treats the × and ÷ operators in the same way as the + and – operators - in this case $80 \times 4\%$ will equal 256. This button is only applicable in decimals mode.
- **π** : - value of 3.141592653589793 used in calculations; value displayed depends on the number of decimal places chosen.
- **e** : - value of 2.718281828459045 used in calculations; value displayed depends on the number of decimal places chosen.
- **C/Y** : - in Financial mode, the frequency of compounding (default is Monthly i.e. $C/Y=12$) - press the button to change the frequency - other options are Annually ($C/Y=1$), Semi-Annually ($C/Y=2$), Quarterly ($C/Y=4$), Bi-Weekly ($C/Y=26$), Weekly ($C/Y=52$), Daily (360) ($C/Y=360$) and Daily (365) ($C/Y=365$). Long press the C/Y button to add another value to the frequency of compounding and payments list.
- **P/Y** : - in Financial mode, the frequency of payments or cash flows (default is Monthly i.e. $P/Y=12$) - press the button to change the frequency - other options are Annually ($P/Y=1$), Semi-Annually ($P/Y=2$), Quarterly ($P/Y=4$), Bi-Weekly ($P/Y=26$), Weekly ($P/Y=52$), Daily (360) ($P/Y=360$) and Daily (365) ($P/Y=365$). Long press the P/Y button to remove a value from the frequency of compounding and payments list.

Other options available via the 'Settings' tab in the menu include:

1. the start mode of the calculator,
2. whether to use radians, degrees or gradients in trigonometric calculations (default is radians),
3. whether to show inline computations on the Sci and Hex/Oct/Bin screens (default is On),

4. whether to use multi-colored sets of parentheses (default is On),
5. the maximum number of decimal places to round to (default is 4) - please note that the number of decimal places when in financial mode is 2 (except the interest rate which uses the scientific mode setting),
6. the maximum number of digits that can be input in SCI mode (default is 12, maximum is 30),
7. the display format when in decimals mode - standard decimal notation, scientific notation or engineering notation (can also be changed by pressing the FSE button on the Sci Calc screen - in this case, an alert is shown which can be disabled in the Settings if required) - in the cases of either scientific notation or engineering notation, the significant digits will be those set in the decimal places selection and either 'SCI' or 'ENG' will be shown in the output display - when using engineering notation, there is also an option to use symbols for the metric prefixes femto, pico, nano, micro, milli, kilo, mega, giga, tera and peta by long pressing the buttons 0 - 9,
8. the maximum number of records to be stored in the calculation history (default is 10 records),
9. whether to add a timestamp to a history record (default is Off),
10. whether to use \div or $/$ as the division sign (default is \div),
11. whether to set the output to scroll horizontally or vertically (default is vertical in which automatic scroll to end can be either enabled or disabled in the 'Settings' - default is enabled),
12. whether to keep the screen on when the calculator is in use (default is Off),
13. whether to set to full screen mode (i.e. no notification bar) for the calculator screens (default is Off),
14. whether to enable vibration mode for the calculator buttons (default is On) plus, if so, the ability to set the vibration level (low, medium or high - the default is high), and
15. whether to convert the calculator to fractions mode rather than decimals mode (default is decimals mode).

The Reference section includes:

1. Physical Laws - a listing of physical laws is displayed in chronological order of their discovery and / or publication - press any item in the list for a brief description of each law - this list can also be viewed alphabetically if required - choose the mode via the 'Settings' tab.
2. Names in the Metric System.
3. Useful Mathematical Formulas.
4. Log & Antilog Tables.
5. Normal Distribution Table.
6. Elementary Algebra.
7. Matrix Algebra.
8. Trigonometric Identities.
9. Differentiation Rules.
10. Integration Rules.
11. Statistics Formulas.
12. ASCII Converter.
13. Fractional Bits Converter.
14. Roman Numeral Converter.
15. pH Calculator.
16. Interpolation Calculator.
17. Body Mass Index (BMI) Calculator.
18. Proportion Calculator.
19. Sigma and Pi Notation.
20. Percentage Calculator.
21. Number Base Converter.
22. Molecular Weight Calculator.
23. Balancing Chemical Equations.
24. Statistics (Grouped Data).
25. Numerical Sequences.
26. Humidity Calculations.
27. Boolean Algebra Calculator.
28. Empirical Formula Calculator.
29. Characteristics of an RLC Circuit.
30. Feet and Inches Calculator.
31. Aspect Ratio Calculator.
32. Barometric Formula Calculator.
33. Linear Regression Analysis.
34. IEEE 754 Converter.

35. Color Calculator.
36. Bicycle Tire Pressure Calculator.

REVERSE POLISH NOTATION (RPN)

Reverse polish notation is available for Sci Calc, Basic and Hex/Oct/Bin modes. RPN can be enabled for each of these modes in the "General Settings" group of the Settings. RPN is also known as postfix notation because the operands are entered first followed by the operator. RPN uses stack based evaluation. Values are pushed onto the stack by pressing the ENTER button. An operation that requires two arguments takes the top two numbers off the stack, makes the calculation based on the operator, and puts the result back on the stack. An operation that requires only one argument, takes the value from the X register of the stack and replaces it with the result of the operation. The following examples illustrate the use of RPN:

1. The sum of 2 and 3 is obtained by the sequence "2 ENTER 3 +"
2. The result of 3^4 is obtained by the sequence "3 ENTER 4 x"
3. The cosine of 0.23 is obtained by the sequence "0.23 cos"

Please take note of the specific use of the following buttons:

- ENTER : Used to push values onto the stack. In the case where the value in the X register is a computed value, entering another value from the number pad automatically pushes the previous value onto the stack without the need to press the ENTER button.
- DROP : Removes the value in the X register and shifts the remaining stack downwards.
- $X \leftrightarrow Y$: Swaps the values in the X and Y registers.
- UNDO : Reverses the last operation.
- LastX : Contains the value that was in the X register before the last operation.

There are separate memories and histories for each of the modes that use RPN. The result of each operation is stored in the history (up to a maximum of 100 records). The history can be accessed via the ANS button and a record from the history can be inserted into the X register by clicking the relevant result.

Long pressing on a register in the stack copies the value in that register to the clipboard. The value can then be pasted into the X register using the Paste icon.

If a value is obtained from the memory, the history, the clipboard or the LastX button, it is handled as follows:

1. If the value in the X register is 0, the new value overwrites this value.
2. If the value in the X register is not 0, it is automatically pushed onto the stack and the new value is inserted into the X register.

AUTOMATIC BACKUP

If the app has been downloaded from Google Play, there is an option in the Settings, "Automatic Backup", which allows the data and the settings to be backed up to Google's remote "cloud" storage. This includes the calculation history, memory registers, custom formulas etc. as well as any specific changes made in the Settings.

In the case of an uninstall and reinstall, or an installation onto a new device, the backed up data and settings are automatically restored during the new installation.

To enable this facility, this option needs to be selected in the Settings and the option "Backup and Reset" needs to be enabled on the device (go to Settings, Backup and Reset, then enable Back up my data and Automatic restore).

If automatic backup is enabled, on quitting the app, any changes in data, or in the Settings, result in a backup request being added to the Backup Manager queue on the device. The Backup Manager on each device handles all the data transactions with the cloud storage. The actual timings of the data transactions are decided by the Backup Manager.

SCREEN TRANSITIONS

Swiping the screen can be enabled in the Settings if required.

If enabled, swiping the screen from left to right will cycle through the 12 calculator screens in the order Scientific → Hex/Oct/Bin → Graphing → Matrices → Complex Numbers → Quick Formulas → Quick Converter → Time Calculator → Equation Solver → Calculus → Financial → Periodic Table → Scientific - a return to the previous calculator screen can be achieved by swiping the

screen from right to left. When in Scientific mode, Basic mode can be obtained by swiping the screen from right to left.

Alternatively, the relevant button in the menu can be used to go directly to a given calculator screen.

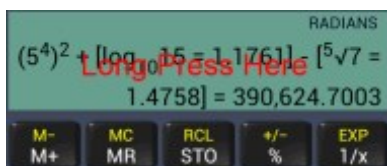
In addition, as the back button on a phone or tablet is the standard method for returning from any of the screens (functions, menu items, settings, history etc.), it can also be used to return to all previous calculator screens.

To return directly to the main screen, press the 'Sci Calc' button in the menu.

There are two ways to exit the app. The first way uses the back button on the main 'Sci Calc' screen – the second way uses the Quit button found in the menu of all of the screens.

EDITING AN EXPRESSION

An expression can be edited by long pressing the output display following which a cursor (||) will be displayed and two of the buttons on the keypad will have arrow keys that allow the user to move the cursor either left or right - to relocate the cursor, you can touch the general area of the expression that you want to edit and use the arrow keys to fine-tune the cursor position or, alternatively, just use the arrow keys - changes (deletions or insertions) can then be made at the cursor position - inline computations are automatically disabled when in this mode - a return to calculation mode can be made by long pressing the output display again.



In most modes the arrow keys are on the parentheses buttons where a short press will move the cursor either left or right (in this mode, input of parentheses requires a long press) - if desired, this can be changed to a long press in the Settings by deselecting the "Swap Parentheses and Arrow buttons" option - the exceptions are Equations mode, where the "Mode" and "Solve" buttons are changed to arrow buttons when in edit mode, and Matrices mode, XY Scatter Plot mode and Interpolation mode where the "STO" and "RCL" buttons are changed to arrow buttons when in edit mode.

This function is designed to allow simple changes to be made to an expression - it should not be used to make significant changes to an expression as there is always the possibility of damage to the syntax of the underlying expression that is used for calculation.

Please note that in HEX/OCT/BIN mode, edit mode is not available when a left or right hand shift is present in the expression.

MEMORIES

There are two types of memory available as follows:

Cumulative Memory

The relevant buttons are as follows:

- **M+ & M-** : add or subtract either the current numerical entry (can be changed to the running total in the Settings) or the result of a calculation to the memory - please note that, in Sci Calc or Basic mode, there is also an option in the Settings to reset the input after pressing the M+ or M- buttons thus allowing another number (in the case where no operator has been entered), or another expression (if "Use Running Total for M+ and M- buttons" has been enabled in the Settings), to be entered and subsequently added to, or subtracted from, the memory - an alert is shown when a number is successfully added or subtracted from the memory; this can be disabled, if required, by unchecking the 'Memory Alert' section in the 'Settings' tab - please note that the numbers shown in the alert are the rounded numbers dependent upon the maximum number of decimal places chosen in the 'Settings' tab whilst the non-rounded numbers are used for calculations - if a number is being held in memory, 'MEM' will be displayed at the top of the results box.
- **MR & MC** : MR recalls the number in the memory; MC cancels the memory and sets it to 0.

Memory Registers

Memory registers are available for all calculator screens (20 separate registers for each screen). These registers provide long-term memory that is preserved once the application is closed. The full contents of the results screen (i.e. either a single number or, if the equals sign has not been pressed, a full expression) can be stored via the 'STO' button and accessed via the 'RCL' button. Short-

press on the desired memory register to either store the value or to retrieve it. The memory registers can be reset to zero by pressing the 'Reset All Registers' button shown on the screen after pressing either the 'STO' or 'RCL' buttons - alternatively, a single memory register can be reset to zero by long-pressing on the relevant memory register when in 'Store Value' mode.

HISTORY

The text of each calculation is shown as it is input. Once a calculation is completed, the full text is automatically stored in the calculation history which can be viewed via the 'History' tab in the menu. The maximum number of records that can be stored can be chosen in the 'Settings' tab - up to 1000 records can be stored - the default is 10 records - once the maximum has been reached, the newest entry will overwrite the oldest entry - the number of records that are currently stored (and the percentage of storage vs. the chosen maximum setting) is displayed together with the history. The input to the history is prefixed to show which category of numbers was used to perform the calculation i.e. 'SCI' or 'FRA' (from the main calculator screen), 'HEX', 'OCT', 'BIN' & 'DEC'.

The results of the calculations stored in the history can be input into a calculation by short pressing on the relevant calculation text - the value will be converted according to the mode that the calculator is in when the history is accessed - for example, a fraction would be converted to decimals when not in fractions mode and a decimal would be converted to a fraction if in fractions mode - similarly, 'HEX', 'OCT', 'BIN' & 'DEC' results are converted depending on the current calculator mode - the history will only show records that are relevant for the particular calculator screen - for example, 'HEX', 'OCT', 'BIN' & 'DEC' results will not be shown on the Graphing screen - statistics, LCM & HCF calculation texts can be viewed in the history but are not available for insertion into a calculation. Very large or very small numbers (i.e. those raised to a power) are not available for insertion into a fraction or when the calculator is in graphing mode.

Long pressing on a record in the list allows a choice to be made to either delete the individual record, copy it to the clipboard, save it to the 'My Constants' list or, in the case of SCI-prefixed expressions, import the complete expression (without the result) into the calculation - alternatively, all the records in the history can be deleted by pressing the 'Delete History' button and the full history can also be copied to the clipboard if needed by pressing the 'Copy to Clipboard' button.

TRIGONOMETRY FUNCTIONS

To input, first press the relevant button (sin, cos etc.) and then input the values - the values can be in either degrees, radians or gradients (choose the appropriate radio button in the 'Settings' menu option or change by long pressing the DRG button when on the scientific calculator screen) - calculated values using parentheses can also be input - if 'Show Computed Results' in the Settings is checked, once the value has been fully input and an operator (+, -, ×, ÷ or =) selected, the calculated value is shown within square brackets for reference within the full text of the calculation.

Hyperbolic functions can also be calculated by pressing the 'hyp-10^x' button - in this mode, sin, cos, tan, asin etc. become sinh, cosh, tanh, asinh etc. - the mode can be reversed by pressing the 'hyp-10^x' button again.

Degrees, minutes and seconds can be entered as follows:

1. Press the relevant button (sin, cos etc.)
2. Press the ° ' " button (a pop-up will appear)
3. Enter degrees, minutes and seconds, each separated by a vertical bar (|), and then press OK
4. The value will be automatically converted to the decimal value of the current mode (degrees, radians or gradients)

Values can be converted to degrees, minutes and seconds in the Conversion Factors function

POWER & ROOT FUNCTIONS

First input the value and then press the relevant button (x^2 , x^3 , $2\sqrt{x}$ etc.) - in the case of squares, cubes or their roots, if the number to be computed is a computed number (trig, log, complex power, complex root etc.) it will, automatically, be fully enclosed by parentheses for computation purposes - if you want a component of a computed number to be squared or cubed, please enclose that component with parentheses manually - for more complex power & root values (i.e. x^y & $\sqrt[y]{x}$), first input the value then press the relevant button, then input the power or root - if 'Show Computed Results' in the Settings is checked, in most cases, once the value has been fully input and an operator (+, -, ×, ÷ or =) selected, the calculated value is shown within square brackets for reference within the full text of the calculation.

Please note that this app, like Microsoft Excel, allows the unary minus operator to have precedence over exponentiation - in this case, $-3^2 = 9$. The precedence can be reversed in the Settings (via the Exponentiation tab) if the user requires exponentiation to

have precedence over the unary minus operator - in this case, $-3^2 = -9$.

An option to enter the root symbol before the entering the value is available in the Settings.

LOG & ANTILOG FUNCTIONS

For \log_{10} and \ln , first press the relevant button and then input the value to be computed - for \log_x , first input the log base value then press the \log_x button and then input the value to be computed - calculated values using parentheses can also be input (but parentheses cannot be used as the log base for the \log_x function) - if 'Show Computed Results' in the Settings is checked, once the value has been fully input and an operator (+, -, ×, ÷ or =) selected, the calculated value is shown within square brackets for reference within the full text of the calculation.

Antilogs, 10^x and e^x , can be calculated by first pressing the hyp- 10^x button (whereby the \log_{10} and \ln buttons will be relabelled to 10^x and e^x respectively - the mode can be reversed by pressing the 'hyp- 10^x ' button again) and then entering a value followed by pressing either the 10^x or e^x buttons.

PERMUTATIONS & COMBINATIONS

First input the total of n objects, then press either 'nPr' or 'nCr' as required then input the r objects - in both cases, once the value has been fully input and an operator (+, -, ×, ÷ or =) selected, the calculated value is shown within square brackets for reference within the full text of the calculation.

HCF, LCM, PRIME FACTORIZATION, REMAINDER, Δ% & CUMULATIVE % FUNCTIONS

Highest Common Factor (or, as it is sometimes called, Greatest Common Divisor - GCD) and Lowest Common Multiple results can be accessed by pressing the 'Func' button, selecting the relevant tab and then inputting each value separated by a vertical bar (|) - once all the values have been entered, press the '=' button and the results will be displayed.

A multiple series of computations can be made once the relevant tab (HCF or LCM) has been pressed - switch back to standard scientific mode by either pressing the 'AC' button or by beginning a scientific calculation directly.

Please note that horizontal scrolling output is not recommended for these functions as the output often takes too long to circulate around the screen.

The Prime Factors that make up a number can be calculated using the 'Prime Factors of a Number' operation found within the list of functions that are accessed by pressing the 'Func' button. The function is generally very fast but performance is likely to be much slower when computing large-digit semiprime numbers.

The Remainder Function calculates the integer quotient and the remainder of value (x) divided by value (y). It can be accessed by pressing the 'Func' button.

The Δ% Function calculates the percentage difference between 2 numbers. It can be accessed by pressing the 'Func' button.

The Cumulative % Function uses the following formula to calculate the cumulative percentage: $\%_{cum} = \{(1+\%_1)*(1+\%_2)*(1+\%_3)*\dots*(1+\%_n)-1\}*100$. It can be accessed by pressing the 'Func' button. Input each of the values (will be automatically converted to a %) separated by a vertical bar (|) & then press an operator (+, -, ×, ÷ or =).

STATISTICS FUNCTIONS

These functions are accessed by pressing the 'Func' button - a wide range of functions are available as below - all results can be included in ongoing calculations except for the functions 'Statistics (Ungrouped Data)', 'Coefficient of Variation' and 'Bessel Functions - Summary' - please note that parentheses cannot be used when computing these functions, however, the number values held in both the Cumulative Memory and the Memory Register can be used - expressions in the Memory Register will be converted automatically to number values prior to use in the computation - the previous function used can be recalled by long pressing the decimal point button:

Statistics (Ungrouped Data)

This choice returns the count (n), sum, product, sum of squares, minimum, maximum, median, mean, geometric mean, mean

absolute deviation, variance, coefficient of variation (CV) and standard deviation (σ) of a series of values. See an option for Statistics (Grouped Data) in the Reference section. Input each of the values separated by a vertical bar (|) then press the "=" button. Negative numbers can be included by first entering the number and then pressing the +/- button (however, please note that the geometric mean will not be computed if negative numbers are included).

A multiple series of computations can be made once the choice has been made - switch back to standard scientific mode by either pressing the 'AC' button or by beginning a scientific calculation directly.

Please note that horizontal scrolling output is not recommended for this function as the output often takes too long to circulate around the screen.

Bessel Functions

This choice contains Bessel functions of the first kind ($J_0(x)$, $J_1(x)$ and $J_n(x)$), Bessel functions of the second kind ($Y_0(x)$, $Y_1(x)$ and $Y_n(x)$), Modified Bessel functions of the first kind ($I_0(x)$, $I_1(x)$ and $I_n(x)$) and Modified Bessel functions of the second kind ($K_0(x)$, $K_1(x)$ and $K_n(x)$). A summary of each of the functions at a given value is obtained by choosing 'Bessel Functions - Summary', inputting a value and then pressing the "=" button (a multiple series of computations can be made once the choice has been made - switch back to standard scientific mode by either pressing the 'AC' button or by beginning a scientific calculation directly). Individual values of the order of 0 and 1 are obtained by choosing the relevant function, inputting a value and then pressing the vertical bar (|) button. Individual values of the order of n are obtained by choosing the relevant function, inputting an integer (n), pressing the vertical bar (|) button, then inputting an argument value and pressing the vertical bar (|) button again.

Please note that horizontal scrolling output is not recommended for this function as the output often takes too long to circulate around the screen.

Beta Function

This choice returns the beta function. Input values for x and y separated by a vertical bar (|) and then press the vertical bar (|) button again. Please note that large numbers cannot be computed - the maximum sum of value(x) and value(y) is 171

Beta Probability Density

This choice returns the probability density function of the beta distribution. Input values for α , β and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Beta Probability Density

This choice returns the cumulative probability density function of the beta distribution. Input values for α , β and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Binomial Distribution

This choice returns the individual term binomial distribution probability. Input values for number of successes, number of trials and probability of success each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Binomial Distribution

This choice returns the cumulative binomial distribution probability. Input values for number of successes, number of trials and probability of success each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Negative Binomial Distribution

This choice returns the negative binomial distribution probability. Input values for the threshold number of successes, the number of failures and probability of a success each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Chi-Squared Distribution

This choice returns the one-tailed probability of the chi-squared distribution. Input a value to evaluate the distribution (x) and the degrees of freedom (df) separated by a vertical bar (|) and then press the vertical bar (|) button again.

Coefficient of Variation

This choice returns the coefficient of variation. Input each of the values separated by a vertical bar (|) then press the "=" button. Negative numbers can be included by first entering the number and then pressing the +/- button. This function is also returned as part of the 'Statistics (Ungrouped Data)' function.

A multiple series of computations can be made once the choice has been made - switch back to standard scientific mode by either pressing the 'AC' button or by beginning a scientific calculation directly.

Please note that horizontal scrolling output is not recommended for this function as the output often takes too long to circulate around the screen.

Confidence Interval, Mean

This choice returns the confidence interval for a population mean. Input values for sample size, standard deviation and the significance level used to compute the confidence level (a number greater than 0 and less than 1 - e.g. 0.95 if it is for a 95% significance level), each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Digamma Function

This choice returns the digamma function. Input a value and then press the vertical bar (|) button.

Error Function

This choice returns the error function. Input a value and then press the vertical bar (|) button.

Complementary Error Function

This choice returns the complementary error function. Input a value and then press the vertical bar (|) button.

Exponential Density

This choice returns the probability density function of an exponential distribution. Input a value(x) and a parameter(λ) separated by a vertical bar (|) and then press the vertical bar (|) button again.

Fisher F Density

This choice returns the F probability distribution. Input a value(x) to evaluate, a parameter(a) to represent the numerator degrees of freedom and a parameter(b) to represent the denominator degrees of freedom, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Gamma Function

This choice returns the gamma function. Input a value and then press the vertical bar (|) button. Please note that values greater than 171 cannot be computed.

Gamma Probability Density

This choice returns the gamma distribution. Input values for α , β and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Gamma Probability Density

This choice returns the cumulative gamma distribution. Input values for α , β and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Hypergeometric Distribution

This choice returns the hypergeometric distribution. Input values for the population size, the sample size, the population successes and the sample successes each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Hypergeometric Distribution

This choice returns the cumulative hypergeometric distribution. Input values for the population size, the sample size, the population successes and the sample successes each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Normal Distribution

This choice returns the normal distribution for a specified mean and standard deviation. Input a value, a mean, and a standard deviation each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Normal Distribution

This choice returns the cumulative normal distribution for a specified mean and standard deviation. Input a value, a mean, and a standard deviation each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Normal Distribution (Inverse)

This choice returns the inverse of the normal cumulative distribution for the specified mean and standard deviation. Input a value, a mean, and a standard deviation each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Poisson Distribution

This choice returns the Poisson distribution. Input the average rate of success(λ) and the Poisson random variable(x) separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Poisson Distribution

This choice returns the cumulative Poisson distribution. Input the average rate of success(λ) and the Poisson random variable(x) separated by a vertical bar (|) and then press the vertical bar (|) button again.

Student T-Density

This choice returns the two-tailed Student T distribution. Input a value (x) and the degrees of freedom (df) separated by a vertical bar (|) and then press the vertical bar (|) button again.

Weibull Probability Density

This choice returns the Weibull distribution. Input values for k, λ and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Cumulative Weibull Probability Density

This choice returns the cumulative Weibull distribution. Input values for k, λ and x, each separated by a vertical bar (|) and then press the vertical bar (|) button again.

Frequency Distribution (Sturge's Rule)

This choice returns the frequency distribution of the data using Sturge's Rule ($k = 1 + \log_2 N$ rounded up to the highest integer) to determine the number of bins. Input each of the values separated by a vertical bar (|) then press the "=" button.

FACTORIAL FUNCTION

This operation finds the factorial of a non-negative integer - i.e. the product of all positive integers less than or equal to the non-negative integer. First input a number, then press the 'x!' button, then select an operator (+, -, \times , \div or =), following which, if 'Show Computed Results' in the Settings is checked, the calculated value is shown within square brackets for reference within the full text of the calculation.

Please note that the largest number that this calculator can accept on the main calculator screen is 6000, whilst, for space considerations, the largest numbers accepted when in HEX, OCT, BIN & DEC modes are HEX C8, OCT 310, BIN 1100, 1000 &

DEC 200 respectively.

Decimal numbers can also be used - in this case, the Gamma function is used to calculate the result based on the relationship $n! = \Gamma(n+1)$ - the maximum value for decimal numbers is 170.

MODULUS FUNCTION

This operation finds the remainder of division of one number by another. First input a number, then press the 'MOD' button, then enter the divisor - if 'Show Computed Results' in the Settings is checked, once the value has been fully input and an operator (+, -, ×, ÷ or =) selected, the calculated value is shown within square brackets, in the format 'xMODy = result', for reference within the full text of the calculation.

RANDOM NUMBERS

There are two random number functions available. The 'Rdm' button allows a random number between 0.0 and 1.0 to be inserted into a calculation. The 'Rdm_R' button allows a random number within a specific range to be inserted - in this mode, first enter a number representing the lower value of the range, then press 'Rdm_R' and then enter the second number representing the higher value of the range - once the values have been fully input and an operator (+, -, ×, ÷ or =) selected, the random number is shown within square brackets for reference within the full text of the calculation.

FRACTIONS MODE

Press the FRA button to toggle between fractions mode and decimals mode.

This mode provides functionality for simple mathematical expressions including use of parentheses, squares, cubes and their roots - of course, not all fractions return rational numbers when computing a root - if during a root computation an irrational number is returned (i.e. the root is a surd), the user will be warned and that part of the computation will be cancelled.

Fractions are calculated by inputting each value of the fraction (whole number, fraction numerator and fraction denominator - in that order) separated by the $a\frac{b}{c}$ button - once all the values have been entered, the input is ready to be computed via pressing an operator (i.e. +, -, ×, ÷ or = if at the end of a calculation series) or by pressing the x^2 , x^3 , $^2\sqrt{x}$ or $^3\sqrt{x}$ buttons - if the fraction value is less than 1, or is an improper fraction, just enter the fraction numerator and fraction denominator separated by the $a\frac{b}{c}$ button and then press an operator.

For negative fractions, first input all of the values of the fraction - i.e. whole number (if needed), fraction numerator and fraction denominator in that order separated by the $a\frac{b}{c}$ button - and then press the +/- button; if the +/- button is then pressed again, the fraction will be converted back to a positive.

Results can be shown as improper fractions (press the % button to toggle the result between mixed and improper fractions) and input can be automatically simplified via choices in the 'Settings'

HEX, OCT & BIN CALCULATIONS

This functionality is accessed by pressing the 'Hex/Oct/Bin' tab in the menu - a new screen will appear with a full set of calculation options. By default, the Scientific Calculator and the Hex, Oct & Bin Calculator are linked - the last number entered into the Scientific Calculator (or the result of a calculation if the equals button has just been pressed) will be carried into the Hex, Oct & Bin Calculator (and automatically converted to HEX format) - the same effect, in reverse, will happen when a transition is made back from the Hex, Oct & Bin Calculator to the Scientific Calculator. This mode can be turned off in the 'Settings' tab if required via the 'Hex, Oct & Bin Link' checkbox.

First choose the input mode by pressing any one of the HEX, OCT, BIN or DEC buttons - the initial default mode is HEX - conversions of inputs between different modes can also be made via these buttons - first input the number to be converted then press the relevant mode button to convert it to another mode - the result can then be used in ongoing calculations in the new mode.

Both input and calculations are based on 64 bits. As a result, input is limited to 16 characters maximum when in HEX mode, 21 characters maximum when in OCT mode, 64 characters maximum when in BIN mode and 19 characters maximum when in DEC mode - for ease of reading, the characters are formatted with every 4 characters input (or output) separated by a comma (,) when in HEX, OCT or BIN mode and with every 3 characters separated by a comma (,) when in DEC mode (which can be changed to every 4 characters via the 'Settings' tab if required) - this form of formatting is the default mode - it can be turned off via the 'Settings' tab if required.



LEFT HAND SHIFT & RIGHT HAND SHIFT

These functions are available in HEX, OCT, BIN & DEC mode. There are two variants - the 'Lhs' and 'Rhs' buttons enable arithmetic shifts (there is a choice in the 'Settings' to change the 'Rhs' button to a logical shift, i.e. a shift that does not preserve a number's sign bit) whilst the Lhs^C and Rhs^C buttons enable circular shifts. Press the relevant button once and the value will be shown in square brackets - e.g. if you want to perform an arithmetic left shift on the HEX value AB one time, after pressing the 'Lhs' button, the result would show as follows: [AB << 1 = 156] - if you then want to left shift a second time, press the 'Lhs' button again and the result will show as [AB << 2 = 2AC] - the same principle is used to generate right shift values. In the case of circular shifts, the default bit depth for rotation is 64 bits - this can be changed to either 8 bits, 16 bits or 32 bits via the 'Settings' - however, in these cases, if a number is entered that is larger than either 8, 16 or 32 bits respectively, it will initially be truncated such that only the last 8, 16 or 32 bits are used in the computation.

GRAPHING CALCULATIONS

This functionality is accessed by pressing the 'Graph' tab in the menu - a new screen will appear with a full set of graph calculation options

Currently, 4 modes are available, each of which can be selected by pressing the Mode button - the modes are:

1. Standard Mode (STD) - displays up to 7 graphs with an option to show a table of results - the graph can be manipulated by multi-touch (one finger to drag the graph and two fingers for pinch zooming) or use the buttons on the graph for more control over panning and zooming - the graph can be reset by clicking the  icon - toggle between the default size and full screen by clicking the  icon - trace the graphs by touching and dragging the point on each graph - in the case of plotting a single function, buttons to plot the derivative, $f'(x)$, integral, floor (sometimes called greatest integer), modulus function (absolute value) and the function using polar coordinates are available - they are labelled 'D', 'I', 'F', 'M' and 'P' respectively. In this mode, the graph center=(0,0) - this can be disabled in the settings if required.
2. Parametric Equations (PM) - displays a graph in a window determined by the calculated x and y results - the starting point is marked by a blue dot and the path direction is shown by a pointer in the right-hand corner of the graph to indicate that the path initially travels either right (►) or left (◄) - a table of results is available and an animation of the path direction can be shown (particularly interesting for tracking the path of complex Lissajous curves).
3. XY Scatter Plot (XY SCATTER) - displays the best fit of a set of data points using polynomial regression - enter xy data points (at least 3) in format x|y (will be displayed as x;y), each separated by the Next button, then press the graph button - alternatively, data can also be imported from a CSV file - when the graph is displayed, you can change the degree of the polynomial using the arrow buttons - the maximum degree is the degree at which the Coefficient of Determination (R^2) is equal to 1 (or, if non-unique data points have been entered, the maximum degree is equal to the total number of unique data points); the default is a degree of 1 representing a standard two-element linear regression - also displayed are the equation of the polynomial regression curve, the Correlation Coefficient (R), the Coefficient of Determination (R^2) and the Standard Error.
4. 3D Surface Plot (3D) - displays a 3D representation of a surface based on an expression which must contain at least one instance of both x and y - alternatively, a fixed set of data in x,y,z format can be imported directly from a csv file - drag the graph with one finger to rotate it - in the case of an expression, use the slider to zoom in and zoom out - please note that, in this mode, trig calculations are in radians.

The modes that are included in the application can be chosen in the Settings - the default is all modes (if no boxes are checked, all modes is assumed).

A function such as $\sin x + 2x$ is first entered following which the 'Plot Graph' icon button is pressed - note that you can enter $2x$ rather than $2 \times x$ as the system will insert the 'x' sign automatically when the computation is made.

Computations follow algebraic principles - for example, $\sin 2x$ will be interpreted as $(\sin(2)) \times x$ - if you want to compute the sine of $2x$, you would need to input $\sin(2x)$.

Minimum and maximum values for x can be input at the bottom of the calculator screen - these are decimal values - the default for x min is -10.0 and the default for x max is 10.0.

In standard mode, once the graph has been displayed, buttons are available to both show and hide a table of results for x and y - the data range for x can also be expanded and contracted by pressing the +, -, y:x+ and y:x- buttons respectively - by default, these functions work by automatically doubling or halving the x min and x max values - the zoom level can be changed in the settings (a higher percentage represents a smaller change).

Also, please note that, for consistency with the other calculator screens, squares, cubes etc. are labelled as x^2 , x^3 etc. - these buttons are for all numbers including x - if you want to input the square of x , first press x then press x^2 .

Expressions can be used as exponents in complex powers and roots but must be enclosed in parentheses - if a negative expression is required, press the +/- button after closing the parentheses (useful for plotting bell curves such as $e^{-(x^2+2)}$ or similar expressions).

In standard mode, up to 7 expressions can be plotted on the same axis - to enter additional expressions press the 'More' button - for viewing convenience, the expressions will be shown separated by || characters.

CONVERSION FACTORS

Conversions between different units can be made by first entering the number and then pressing the 'Conv' button following which a choice can be made of the unit categories (distance, area, volume etc.) followed by the units to convert from and the units to convert to - the calculated value is shown within square brackets for reference within the full text of the calculation - calculated values using parentheses can also be input.

Please note that, in the 'Data Size' section, this app follows the International Electrotechnical Commission (IEC) standard where kb, mb, gb etc. are multiples of 1000 and kibi-, mebi- etc. are multiples of 1024 - see this link for details: [Prefixes for binary multiples](#).

Exchange rate data is supplied by our server where the values are updated once per hour. Every time the app is opened, it will check if the latest data is stored on the user's device. If not, the latest data is downloaded in the background automatically. This can be disabled in the Settings if the data is not required.

In the Audio Signal Level category, dBu and dBV are voltage ratios relative to 0.7746V rms (1 mW, 600 ohms) and 1V rms respectively

There is also a separate Quick Converter screen available for stand-alone multiple conversions - results from the history can also be imported into this screen for conversion - with this option, please note the following:

- To swap the 'Units From' and 'Units To', press the \leftrightarrow icon.
- To enter negative numbers, first press the $-$ button.
- In the Distance category, when converting from feet and inches, press the ', ' button before entering inches - fractions can be used if converting from inches (first enter the numerator, then long press the decimal point button, then enter the denominator).
- In the Angles category, when converting from degrees, minutes and seconds, press the '° ' " button before entering minutes and seconds.
- The AC button clears everything whereas the DEL button deletes the last entry made.

The Quick Converter can be linked to the Sci Calc screen by means of an option in the Settings - if enabled, when Sci Calc is chosen from the menu in Quick Converter, the converted number is transferred to the Sci Calc screen to allow further computations to be made. Touch the result to copy it to the clipboard.

Favorite conversions can be assigned to the 1-9 buttons in the quick converter by long pressing the relevant button and following the directions - once a conversion has been assigned to a button it can be accessed by long pressing the button - if the button assigned to the conversion is long pressed when the assigned conversion is in the view, there is an option to edit the conversion assigned to that button.

CONSTANTS

A wide range of constants and general mathematical information can be accessed by pressing the 'Const' button following which a choice can be made of the desired constant value which is then available for use in further computations.

The constants included are currently divided into 4 categories:

1. **Physical & Astronomical Constants** : press to input the constant's value into a calculation or long press to access further information about the constant and its relationship to other constants.
2. **Periodic Table - Atomic Mass (u)** : press to input the element's atomic mass into a calculation or long press to access further information about the specific element chosen. The list of elements can be sorted either by atomic number or alphabetically - choose the mode via the 'Settings' tab - the default is sorting by atomic number.
3. **Solar System - Orbit Distances (km)** : press to input the planet's orbit size around the sun (semi-major axis) into a calculation or long press to access further information about the specific planet chosen.

4. **My Constants** : personal constants can be included by long pressing a SCI-prefixed result (excluding statistics, LCM & HCF calculation texts) in the History and giving it a suitable name - press to input the constant's value into a calculation or long press to delete the constant from the list.

MATRICES

Two separate modes of data entry are available, either Decimals mode or Fractions mode. Long press the AC button to change between each mode. In Fractions mode, either proper or improper fractions can be entered by first entering the numerator, then pressing the $\frac{\Box}{\Box}$ button and then entering the denominator. Please note that, in Fractions mode, the computation of Eigenvalues and the various decompositions (LU, QR etc.) are not available.

Matrices of dimensions up to 9x9 can be computed. Begin by inputting row & column values (max 9 for each) for Matrix A, then input the matrix values pressing ENTER each time - after that, Matrix B can be set up and the data entered following which a choice of computations can be made. For negative numbers, enter the minus value before entering the number.

If you only want to work with one matrix, Matrix B can be disabled by long pressing on the white area of the screen where the contents of Matrix B appear - in this mode, scalar values can be entered into the Matrix B box - once disabled, Matrix B can be re-enabled by long pressing the white area of Matrix B again.

Matrices can be stored in the memory registers for future use - after each matrix has been entered, press the STO button to store its values in a memory register - the value can be used in a computation by pressing the RCL button and choosing the relevant matrix from the list. If the result of a computation is a matrix, it can also be stored in a memory register by pressing the STO button once a computation has been made - select the matrix to be stored by first touching the relevant matrix on the screen (Matrix A, Matrix B or the results area of the screen) and then pressing the STO button - if no area of the screen has been touched immediately prior to pressing the STO button, the value available will default to either the last matrix entered or the result if it has already been computed.

If required, the previous matrix can be recalled into its relevant box by first touching the relevant matrix box and then long-pressing the ENTER button.

COMPLEX NUMBERS

Complex numbers can be entered in any of 3 different formats:

1. **Cartesian.**
2. **Polar.**
3. **Via Euler's Identity.**

Output can also be in any of these 3 formats by making a selection in the 'Settings' – the default output setting is Cartesian - once the "=" button has been pressed, the Mode button can be used to show the result in each of the other formats. Entries are made as follows:

Cartesian

Complex numbers consisting of real and imaginary parts must be entered in parentheses in the format $a + bi$ or $a - bi$ where "a" is the real part and "b" is the imaginary part – hence a complex number $2 + 3i$ would be entered as $(2 + 3i)$ – if, for example $3i$ is entered without surrounding parentheses, the real part will be assumed to be zero – similarly, if $(2 \times 3i)$ is entered, the calculation required will be assumed to be a real number 2 multiplied by a complex number $3i$ which has a real part of zero.

Polar

Use the cis button to enter complex numbers in polar form where the $\text{cis}\theta$ function is a shorthand way of writing the equivalent expression $\cos\theta + i.\sin\theta$ – entries are made in the format $r \text{ cis } \theta$ where r is the modulus and θ is the phase angle in radians (can be changed to degrees in the Settings if required - the output will then also be in degrees).

Via Euler's Identity

Use the $e^{i\Box}$ button to enter complex numbers via Euler's Identity where $e^{i\theta}$ is a shorthand way of writing the equivalent expression $\cos\theta + i.\sin\theta$ – entries are made in the format $r e^{i\theta}$ where r is the modulus and θ is the phase angle in radians (can be changed to degrees in the Settings if required - the output will then also be in degrees). The alpha operator (α) is a special case of Euler's Identity where $\theta = \frac{2}{3}\pi$ radians or 120° .

In addition to trigonometric, log, power and square root functions, the complex number screen also includes the abs function, which

returns the absolute value of a complex number, and the exp function, which implements the exponential function e^x for the complex number.

QUICK FORMULAS

Choose the formula and then enter the values followed by pressing the 'NEXT' button - one of the values can be left as unknown by just pressing the 'NEXT' button - note that, in the case of the Ohm's Law formula, two unknown values are allowed.

Clear all the entries by pressing the 'AC' button - correct a single entry by pressing the 'DEL' button before pressing the 'NEXT' button - to edit an already committed entry, touch the area of the screen for the field that you want to change, make the changes, then press the 'NEXT' button.

Please note that some of the formulas contain several parameters and that you may need to scroll down through the list to see all of them.

The result can be added to the history if required - check the box **before** computing the formula - this checkbox can be hidden by choosing "Quick Formulas - Hide Add to History Checkbox" in the Settings.

Touch the result to copy it to the clipboard

Favorite formulas can be assigned to the 1-9 buttons by long pressing the relevant button and following the directions - once a formula has been assigned to a button it can be accessed by long pressing the button - if the button assigned to the formula is long pressed when the assigned formula is in the view, there is an option to edit the formula assigned to that button. There is an option in the Settings to link the favorite formulas so assigned to the 1-9 buttons on the Sci Calc screen.

CUSTOM FORMULAS

- Custom formulas can be added by choosing the Add Custom Formula option from the list in the Quick Formulas screen.
- This function is designed to handle relatively simple formulas with no guarantee that complicated formulas will return a result.
- Up to 7 variables can be used - they are listed in Greek letters on the top buttons of the Create Formula screen.
- If you want a variable to be used as an exponent in a power or root, enclose it with parentheses to ensure that it is formatted in the output correctly.
- The variable letters can be changed, if required, once the formula has been entered and the NEXT button has been pressed.
- After pressing the NEXT button, choose a unique name for the formula, change the variable letters if required (either 1 or 2 characters but at least one must be an alphabetical letter) and name the variables (minimum 4 characters, at least one of which must be an alphabetical letter).
- When satisfied with the names, press Submit - if you would like to go back and edit the formula, press Back - if you would like to cancel the operation, press Cancel.
- Once Submit has been pressed, the custom formula is added to the list of formulas available in the Quick Formulas screen.
- Please note that the computation algorithm used does not allow division by zero so please be careful when constructing formulas involving division.
- Please note that this function is not designed to solve for all the roots of a polynomial equation and that it will only handle real numbers.
- The custom formula can be deleted by choosing the Delete Custom Formula option from the list in the Quick Formulas screen.
- The current trig setting (radians, degrees or gradients) is recorded when creating a Custom Formula.

TIME CALCULATOR

The time calculator can be accessed via the menu on the main calculator screen or by swiping the screens - the time calculator follows the Quick Converter screen.

Enter a time value by using the : button to separate hours, minutes and seconds. In addition to processing one or more time values, normal decimal numbers can also be used to act on a time value - the result will be displayed as a time value.

Long press the = button to toggle the result between a time value and a decimal value.

All calculations are stored in the History and the results can be imported into the SCI screen, via the History, where they will be automatically converted into decimal values.

The time calculator can, of course, also be used to process values in degrees, minutes and seconds.

By default, the user will be alerted if the values entered for minutes and seconds are not less than 60 - this can be turned off in the

Settings, following which values that are not less than 60 will be automatically converted to hours and minutes or hours, minutes and seconds as appropriate.

The world time function can be accessed by pressing the Time button. To find a world time at a time other than the current time, first enter a time value (HH:MM:SS) then press the Time button. The output from this function can be used in a time calculation by pressing an operator (+, -, × or ÷).

Date functions can be accessed by pressing the Dates button - please note that results from Date functions are not stored in the history. The app uses the ISO 8601 calendar system for years starting from 1583 and the Gregorian/Julian calendar system for years before 1583. In the case of date or date-time entry, if the colon button is pressed first, today's date or date-time is entered automatically - will also be the case if the "=" button is pressed immediately after the colon button.

The stopwatch can be started by pressing the stopwatch icon button and stopped by pressing the same button again. The output from the stopwatch can be used in a time calculation by pressing an operator (+, -, × or ÷). The last 50 records from the stopwatch are automatically stored in a dedicated history which can be accessed by long pressing the decimal point button.

The countdown timer can be accessed by pressing the hourglass icon button and cancelled by long pressing the same button. When the countdown has ended a notification will sound based on the user's device settings - the notification will also sound if the user has either closed the app via the back button, (but not if the Quit button is used), or has selected another calculator mode.

EQUATION SOLVER

Currently, 8 modes are available, each of which can be selected by pressing the Mode button - the modes are:

1. **Solve Simultaneous Linear Equations (LINEAR EQUATIONS)** : enter equations in the format $na + nb + nc \dots = a$ constant, (e.g. $2a + 3b - 6c = 5$, each separated by the NEXT button, then press Solve - note that the letter for the unknown term will be automatically changed after each term is entered - up to 6 unknown terms are allowed - the number of equations must match the maximum number of unknown terms - if "b" is used, the minimum number of equations is 2; if "c" is used, the minimum number of equations is 3; if "d" is used, the minimum number of equations is 4, if "e" is used, the minimum number of equations is 5 and if "f" is used, the minimum number of equations is 6 - a _ symbol is used to indicate that the NEXT button has been pressed and another equation should be entered - if $n = 1$, there is no need to enter 1 as it is assumed - if $n = 0$ for any unknown, the unknown button should be pressed again (e.g. if the last unknown was "a", pressing the unknown button once will give "b", pressing it twice will give "c" etc.).
2. **Solve Roots of a Polynomial Equation (POLYNOMIAL EQUATION)** : enter a polynomial equation containing at least 1 value of x, then press Solve. Note that the maximum index is 9. Equations that have not been simplified can be entered (e.g. $((7x + 4) - 3 + 6) \div 4 = x^3 \div 2$) - such equations will be simplified and converted to a polynomial equation (if it is possible) during the calculation process.
3. **Solve Inequalities (INEQUATIONS)** : enter an equation containing at least 1 value of x and a comparison operator, then press Solve.
4. **Factorization of Polynomials (POLYNOMIAL FACTORS)** : please note that this mode can only accept integer coefficients - enter a polynomial in the format $nx^y + nx^z \dots + nx + a$ constant (if required), then press Solve - the order of entry of each x term is not important - if $n = 1$ or the index = 1, there is no need to enter 1 as it is assumed - if $n = 0$ for any x term, the term does not need to be entered.
5. **Greatest Common Divisor of 2 Polynomials (POLYNOMIALS GCD)** : enter 2 polynomials in the format $nx^a + nx^b \dots + nx + a$ constant (if required), separated by the vertical bar (|) button, then press Solve - please use integer values only for the exponents - please note that polynomials containing parentheses can also be used ... for example, $(1 + x)^2 \times (2 + x) \times (4 + x)$.
6. **Lowest Common Multiple of 2 Polynomials (POLYNOMIALS LCM)** : enter 2 polynomials in the format $nx^a + nx^b \dots + nx + a$ constant (if required), separated by the vertical bar (|) button, then press Solve - please use integer values only for the exponents - please note that polynomials containing parentheses can also be used ... for example, $(1 + x)^2 \times (2 + x) \times (4 + x)$.
7. **Binomial Expansion (BINOMIAL EXPANSION)** : enter a binomial expression in the format (expression)^x ... for example, $(a+b)^6$, then press Solve - please note that the expression must contain at least 2 variables - please use integer values only for the exponents.
8. **Vector Arithmetic (VECTORS)** : Enter 2 vectors of equal dimensions, or 1 vector and a scalar value, separated by the NEXT button, each vector in the format number 1 followed by a semi-colon, number 2 followed by a semi-colon, number 3 etc., choose an operation from the drop-down list, then press Solve. e.g. enter 2;4;6 then press NEXT then enter 3;7;9 then choose an operation then press Solve. Once the Solve button has been pressed, the operation can be changed and the Solve button can then be pressed again. If the result is a vector, long press Solve to reuse it in the next calculation.

CALCULUS

Currently, 5 modes are available, each of which can be selected by pressing the Mode button - the modes are:

1. **Derivative** : enter a function of x, choose the derivative level, and then press Calculate. After the calculation, long press the output display to show a graph of the input and result.
2. **Definite Integral** : enter a function of x, choose the limits (x_1 and x_2), and then press Calculate.
3. **Taylor Series** : enter a function of x, choose the point to compute at and the power, and then press Calculate (trigonometric values are in radians).
4. **Indefinite Integral** : enter a function of x and then press Calculate. After the calculation, long press the output display to show a graph of the input and result (in this case, the constant value in the result is assumed to be zero).
5. **Limit of a function** : enter a function of x, choose the limit ($x \rightarrow$) and then press Calculate - only available for simple functions where the left-side limit is equal to the right-side limit - in cases where this is not true, an attempt will be made to display the left-side and right-side limits.

Long press the Calculate button to copy the result to the clipboard.

Calculus mode is based on the computer algebra library developed by [Axel Kramer](#)

PERIODIC TABLE

The pictorial version of the periodic table can be accessed via the menu on the main calculator screen or by swiping the screens - the periodic table follows the Financial screen. Click on the back key of your device to return to the previous screen or use the menu to return to the main screen.

Click on each of the elements to see details of that element. Click on 'Show Legend' to see the listing of the element groups.

SIGMA AND PI NOTATION

- Enter a function of x, choose the limits (Start and End), and then press Calculate.
- Use the Mode button to toggle between Sigma and Pi notation.
- Long press the Calculate button to see details of the calculation.
- The maximum difference between the Start and End values is 10000.

PERCENTAGE CALCULATOR

4 modes are available:

1. **Percentage of a Number** : evaluates the expression $a \times b / 100 = c$
2. **Percentage Discount** : evaluates the expression $a - (a \times b / 100) = c$
3. **Percentage Surcharge** : evaluates the expression $a + (a \times b / 100) = c$
4. **Tip Calculator** : there are two options available:

Payment Rounding: this option, when checked, allows that, in the case where the invoice cannot be split exactly between all of the people sharing it, all of the people except one will pay a whole number (no cents) whereas the remaining person will pay a slightly higher number (including cents, if appropriate) to make up the balance.

Tip Rounding: there are 4 modes to choose from:

1. No Rounding (the default).
2. To Multiples of 1.00 - the tip is rounded up to the nearest whole number.
3. To Multiples of 5.00 - the tip is rounded to the nearest 5 whole number - i.e. if 5 or over will round up to 10, whereas if under 5 will round up to 5 - i.e 7 will round up to 10, whereas 4 will round up to 5.
4. To Multiples of 10.00 - the tip is rounded to the nearest 10 whole number - i.e. if 5 or over will round up to 10, whereas if under 5 will round down to the next nearest multiple of 10 - i.e. 15 will round up to 20, whereas 14 will round down to 10.

In all modes, to edit an already committed entry, touch the area of the screen for the field that you want to change, make the changes, then press the 'NEXT' button.

MOLECULAR WEIGHT CALCULATOR

This mode calculates the molar mass of a chemical compound (g/mol).

- Enter a chemical compound (e.g. CaCO_3), then press Calculate.
- To enter compounds that contain water of crystallisation, first enter the compound, then press the "." button, then enter the number of molecules of water of crystallisation (if more than 1), then press the H_2O button.
- Long press the Calculate button to copy the result to the clipboard.

BALANCING CHEMICAL EQUATIONS

This mode finds the coefficients of a chemical equation and allows calculations involving reaction stoichiometry.

- Enter an equation of a chemical reaction (e.g. $\text{Fe} + \text{Cl}_2 = \text{FeCl}_3$), then press Balance.
- To enter an ion, specify charge after the compound using either the $^+$ button or the $^-$ button, followed by a number if the charge is higher than 1 (for example, to enter Fe^{3+} , press Fe, then press $^+$, then press 3).
- When an equation has been balanced, calculations involving reaction stoichiometry can be made by long-pressing the Balance button.
- An equation can be edited by long pressing the output display following which a cursor (||) will be displayed and two of the buttons on the keypad will have arrow keys that allow the user to move the cursor either left or right (in this mode, input of parentheses requires a long press).

This mode is based on open source software developed by [Berkeley Churchill](#)

STATISTICS (GROUPED DATA)

This mode returns the minimum, maximum, mode, median, mean, mean absolute deviation, variance and standard deviation (σ) of a set of grouped data. See the list of functions ("Func" button) for an option for Statistics (Ungrouped Data).

- Enter the data points, each separated by a vertical bar ($|$), then press NEXT, then enter the frequencies, each separated by a vertical bar ($|$), then press OK.
- In the data section, class intervals can be entered using the ":" button (e.g. 20:25 is displayed as "20 - 25", meaning from 20 up to, but not including, 25). Please note that, when entering a class interval, the lower limit should be entered before the upper limit. In the case of a class interval, the mid-point is used for the calculation of the mean and the standard deviation.
- Long press either of the two fields to edit its content.
- Long press the OK button to copy the result to the clipboard.

NUMERICAL SEQUENCES

This mode allows the calculation of a specific number in a numerical sequence as well as the calculation of a range of numbers in that sequence. Enter the position of the number in the sequence and then press OK. For a range of numbers, enter the start and end of the range separated by a vertical bar ($|$) and then press OK.

The following sequences are available:

1. Fibonacci Numbers - the numbers in the Fibonacci sequence are characterized by the fact that every number in it is the sum of the two preceding ones. With TechCalc, the maximum position that can be calculated in the Fibonacci sequence is 10000 (or 1000 for Android version 4.4 or lower), whilst the maximum range of positions is 1000.
2. Catalan Numbers - in combinatorial mathematics, the Catalan numbers form a sequence of natural numbers that occur in various counting problems, often involving recursively-defined objects. With TechCalc, the maximum position that can be calculated in the Catalan sequence is 10000 (or 500 for Android version 4.4 or lower), whilst the maximum range of positions is 500 for positions less than, or equal to 1000, and 100 for positions above 1000.
3. Polygonal Numbers - in mathematics, a polygonal number is a number represented as dots or pebbles arranged in the shape of a regular polygon - the sequences included are:
 - Triangular Numbers
 - Square Numbers

- Pentagonal Numbers
- Hexagonal Numbers
- Heptagonal Numbers
- Octagonal Numbers
- Nonagonal Numbers
- Decagonal Numbers

With TechCalc, the maximum position that can be calculated in the Polygonal number sequences is 1000000000, whilst the maximum range of positions is 50000.

4. Bernoulli Numbers - in mathematics, the Bernoulli numbers B_n are a sequence of rational numbers which occur frequently in number theory. With TechCalc, B_{200} is the maximum Bernoulli number that can be calculated, whilst the maximum range of positions is 10.

Long press the OK button to copy the result to the clipboard.

FEET AND INCHES CALCULATOR

This function allows addition, subtraction, multiplication and division of dimensions measured in feet, inches or feet and inches. Please note the following:

- All calculations are made in feet and the result is then converted to feet and inches. For example, during a calculation, 3" is treated as 0.25' and 3" × 3" is treated as 0.25' × 0.25' = 0.0625' = 0.75".
- Use the Mode button to toggle between fractions and decimals mode.
- In the case where a dimension contains both feet and inches, feet values must be whole numbers; inches can include fractions or decimals.
- To enter a fraction, enter each value of the fraction (whole number, fraction numerator and fraction denominator - in that order) separated by the $a\frac{b}{c}$ button - if the fraction value is less than 1, or is an improper fraction, just enter the fraction numerator and fraction denominator separated by the $a\frac{b}{c}$ button.
- Press either the ft or in button after entering each value. Alternatively, once a value has been entered, the system will add a symbol automatically if a mathematical operator (+, −, ×, ÷, =, x^2 , x^3 , $\sqrt[2]{x}$, $\sqrt[3]{x}$) is pressed - in this case, unless the ft button has already been pressed, it is assumed that the value is in feet.
- The result can be converted to other units (yd, ft, in, m, cm, mm) by pressing the Conv button repeatedly.

FINANCIAL MODE

SIMPLE INTEREST MODE

This mode lets you calculate the interest amount and simple future value using the formula:

$$i = pr\frac{n}{t}$$

where:

- i = simple interest
- p = present value
- r = annual interest rate (%)
- n = number of days
- t = days in year (365 or 360)

A graph and accompanying table showing the results is available. The table can be saved to the sd card in csv format by pressing the Export Table button.

COMPOUND INTEREST MODE

This mode lets you calculate the following:

- [Future Value \(FV\)](#)
- [Present Value \(PV\)](#)

- Payment Amount (PMT)
- Number of Periods (NPER)
- Annual Interest Rate (CMPD_INT)

By default, the results displayed are based on an investment. If the calculation is based on a loan, PMT should be entered as a negative number (use the +/- button) and FV should be less than PV (FV = 0 if the loan is to be fully repaid).

Please note that, in this mode, the effective interest rate used (r) is dependent upon the C/Y and P/Y settings via the formula:

$$r = \left(1 + \frac{i}{100 \times C/Y} \right)^{\frac{C/Y}{P/Y}} - 1$$

where i = annual interest rate.

Future Value (FV)

This mode calculates the future value - the formula used depends on whether the payment is made at the beginning of the period or at the end of the period as follows:

$$FV = \frac{(1 - (1 + r)^n) \times (1 + r) \times y}{r} - p \times (1 + r)^n$$

if payment at the beginning of the period, or

$$FV = \frac{(1 - (1 + r)^n) \times y}{r} - p \times (1 + r)^n$$

if payment at the end of the period, where:

- r = effective interest rate (as calculated above)
- n = number of payments
- y = payment per period
- p = present value

p and y are automatically input into the formulas by the app as negative values. A graph and accompanying table showing the results is available. The table can be saved to the sd card in csv format by pressing the Export Table button.

Present Value (PV)

This mode calculates the present value - the formula used depends on whether the payment is made at the beginning of the period or at the end of the period as follows:

$$PV = \frac{\frac{1 - (1 + r)^n}{r} \times (1 + r) \times y - f}{(1 + r)^n}$$

if payment at the beginning of the period, or

$$PV = \frac{\frac{1 - (1 + r)^n}{r} \times y - f}{(1 + r)^n}$$

if payment at the end of the period, where:

- r = effective interest rate (as calculated above)
- n = number of payments
- y = payment per period
- f = future value

PV is returned by the formulas as a negative value which the app automatically converts to a positive value for display; y is automatically input into the formulas by the app as a negative value. A graph and accompanying table showing the results is available. The table can be saved to the sd card in csv format by pressing the Export Table button.

Payment Amount (PMT)

This mode calculates the payment amount - the formula used depends on whether the payment is made at the beginning of the period or at the end of the period as follows:

$$PMT = \frac{(f + p \times (1 + r)^n) \times r}{(1 + r) \times (1 - (1 + r)^n)}$$

if payment at the beginning of the period, or

$$PMT = \frac{(f + p \times (1 + r)^n) \times r}{1 - (1 + r)^n}$$

if payment at the end of the period, where:

- r = effective interest rate (as calculated above)
- n = number of payments
- p = present value
- f = future value

PMT is returned by the formulas as a negative value which the app automatically converts to a positive value for display; p is automatically input into the formulas by the app as a negative value.

Number of Periods (NPER)

This mode calculates the number of periods - the formula used depends on whether the payment is made at the beginning of the period or at the end of the period as follows:

$$NPER = \frac{\ln \left(\frac{((1 + r) \times y - f \times r)}{((1 + r) \times y + p \times r)} \right)}{\ln(1 + r)}$$

if payment at the beginning of the period, or

$$NPER = \frac{\ln \left(\frac{(y - f \times r)}{(y + p \times r)} \right)}{\ln(1 + r)}$$

if payment at the end of the period, where:

- r = effective interest rate (as calculated above)
- y = payment per period
- p = present value
- f = future value
- \ln is the natural logarithm

p and y are automatically input into the formulas by the app as negative values.

Annual Interest Rate (CMPD_INT)

This mode uses the Newton-Raphson Method to calculate the effective interest rate (r) from the formulas for the Payment Amount (PMT) above. The effective interest rate is then converted to the Annual Interest Rate by the formula:

$$CMPD_INT = \left((1 + r)^{\frac{P/Y}{C/Y}} - 1 \right) \times C/Y \times 100$$

CASH FLOW MODE

On entering this mode, C/Y and P/Y are each set to 1 by default. This mode lets you calculate the following:

- Net Present Value (NPV)
- Net Future Value (NFV)
- Internal Rate of Return (IRR)
- Modified Internal Rate of Return (MIRR)

- Discounted Payback Period (DPP)

Net Present Value (NPV)

This mode calculates the net present value using the formula:

$$NPV = -C_0 + \sum_{i=1}^n \frac{C_i}{(1+r)^i}$$

where:

- C_0 is the initial investment
- C_i is each cash flow
- n is the number of cash flows
- r is the discount rate

A graph and accompanying table showing the results is available. The table can be saved to the sd card in csv format by pressing the Export Table button.

Net Future Value (NFV)

This mode calculates the net future value using the formula:

$$NFV = \left(-C_0 + \sum_{i=1}^n \frac{C_i}{(1+r)^i} \right) \times (1+r)^{n+1}$$

i.e.

$$NFV = NPV \times (1+r)^{n+1}$$

where:

- C_0 is the initial investment
- C_i is each cash flow
- n is the number of cash flows
- r is the discount rate

A graph and accompanying table showing the results is available. The table can be saved to the sd card in csv format by pressing the Export Table button.

Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is the discount rate that makes the net present value of all cash flows from a particular project equal to zero. The app uses the Newton-Raphson Method to solve the equation

$$\sum_{i=0}^n \frac{C_i}{(1+r)^i} = 0$$

where:

- C_i is each cash flow (including the initial investment)
- n is the number of cash flows
- r is the unknown IRR value

The Internal Rate of Return (IRR) is not suitable for use if alternating positive and negative cash flows result from an investment - in this case, the Modified Internal Rate of Return (MIRR) is recommended.

Modified Internal Rate of Return (MIRR)

The Modified Internal Rate of Return (MIRR) assumes that positive cash flows generated by a project are reinvested at the

company's cost of capital, and the initial outlays and any resulting negative cash flows are financed at the company's financing cost. The MIRR, therefore, more accurately reflects the cost and profitability of a project than does the IRR. The Modified Internal Rate of Return (MIRR) is calculated by the following formula:

$$\text{MIRR} = \sqrt[n]{\frac{\text{FV, +ve cashflows @ } r}{\text{PV, -ve cashflows @ } r1}} - 1$$

where:

- PV is the Present Value at the beginning of the first period
- FV is the Future Value at the end of the last period
- r is the cost of capital
- $r1$ is the financing cost
- n is the number of equal periods at the end of which the cash flows occur

Discounted Payback Period (DPBP)

A simple payback period calculates the time it would take for a project to break even after the initial expenditure has been made. This, however, ignores the time value of money. The discounted payback period takes the time value of money into account by calculating the present values of all cash inflows before determining the payback period. A project with a negative NPV will not have a payback period. In common with the simple payback period, the discounted payback period has the disadvantage of not taking into account any cash flows received after the payback period (some of which may be negative). It should be used, therefore, in conjunction with another metric (such as MIRR) when evaluating a project's viability.

AMORTIZATION MODE

This mode lets you calculate or, in some cases, plot the following:

- [Payment per Period \(PMT\)](#)
- [Principal Balance \(BAL\)](#)
- [Interest Portion of Payment \(INT\)](#)
- [Principal Portion of Payment \(PRN\)](#)
- [Interest Between Payments \(\$\Sigma\$ INT\)](#)
- [Principal Between Payments \(\$\Sigma\$ PRN\)](#)
- [Amortization Table \(AMT_TABLE\)](#)
- [Amortization Chart \(AMT_CHART\)](#)

Please note that, in this mode, the effective interest rate used (r) is dependent upon the C/Y and P/Y settings via the formula:

$$r = \left(1 + \frac{i}{100 \times C/Y} \right)^{\frac{C/Y}{P/Y}} - 1$$

where i = annual interest rate.

Payment per Period (PMT)

This mode calculates the periodic payment and total amount paid of an amortization (loan etc.) using the formulas:

$$\text{PMT} = \frac{pr}{1 - (1 + r)^{-nt}}$$

and

$$\text{total} = \text{PMT} \times nt$$

where:

- p = principal amount
- r = effective interest rate (as calculated above)
- n = number of payments per year (from the P/Y setting)
- t = term (in years)
- total = total amount paid

Principal Balance (BAL)

This mode calculates the remaining principal balance of an amortization (loan etc.) by first calculating the payment per period, as above, and then using the formula:

$$BAL = p(1+r)^n - \text{pmt} \frac{(1+r)^n - 1}{r}$$

where:

- p = principal amount
- r = effective interest rate (as calculated above)
- n = number of payments made
- pmt = payment per period

Interest Portion of Payment (INT)

This mode calculates the interest portion of a payment of an amortization (loan etc.) in a specified period by first calculating the remaining principal balance in the period immediately prior to the specified period, as above, and then using the formula:

$$INT = \text{bal} \times r$$

where:

- r = effective interest rate (as calculated above)
- bal = balance remaining in the period immediately prior to the specified period

Principal Portion of Payment (PRN)

This mode calculates the principal portion of a payment of an amortization (loan etc.) in a specified period by first calculating the payment per period, as above and then calculating the interest portion in the specified period, as above, and then using the formula:

$$PRN = \text{pmt} - \text{int}$$

where:

- pmt = payment per period
- int = interest portion of a payment

Interest Between Payments (ΣINT)

This mode calculates the sum of the interest payments made between two specified periods using the formulas above.

Principal Between Payments (ΣPRN)

This mode calculates the sum of the principal payments made between two specified periods using the formulas above.

Amortization Table (AMT_TABLE)

This mode plots an amortization table using the formulas above. The table can be saved to the sd card in csv format by pressing the Export Table button.

4 different amortization systems can be chosen as follows:

1. The French amortization system - is the standard method used for calculating amortization and is characterized by equal payments, growth of the principal amortization value and decreasing interest values.
2. The Constant amortization system - is characterized by a constant amortization value and decreasing interest throughout the time.
3. The German amortization system - is characterized by interest paid in advance and equal payments (except for the first installment which is related to the interest) - capital amortization is increasing and the interest payments are decreasing.
4. The American amortization system - is characterized by no amortization, payment is equal to the interest and the last payment includes the principal.

Amortization Chart (AMT_CHART)

This mode plots an amortization chart using the formulas above.

4 different amortization systems can be chosen as follows:

1. The French amortization system - is the standard method used for calculating amortization and is characterized by equal payments, growth of the principal amortization value and decreasing interest values.
2. The Constant amortization system - is characterized by a constant amortization value and decreasing interest throughout the time.
3. The German amortization system - is characterized by interest paid in advance and equal payments (except for the first installment which is related to the interest) - capital amortization is increasing and the interest payments are decreasing.
4. The American amortization system - is characterized by no amortization, payment is equal to the interest and the last payment includes the principal.

COST, SALES & MARGIN MODE

This mode lets you calculate the following:

Cost (CST)

Given the selling price per unit and the margin, this mode calculates the cost per unit.

Selling Price (SEL)

Given the cost per unit and the margin, this mode calculates the selling price per unit.

Margin (MRG)

Given the selling price and cost per unit, this mode calculates the margin.

BREAK-EVEN MODE

This mode lets you calculate the following (in all cases, a graph and accompanying table showing the results is available - the table can be saved to the sd card in csv format by pressing the Export Table button):

Operating Break-Even (BEV_OPR)

The operating breakeven point is defined as the threshold where total operating costs (variable and fixed expenses) are equal to total revenues. It is calculated using the formula:

$$BEV_OPR = \frac{\text{fixed costs}}{\text{price} - \text{variable cost}}$$

Interest Payment Break-Even (BEV_INT)

The interest payment breakeven point takes into account any debt servicing costs and is defined as the threshold where total operating costs (variable, fixed and debt servicing expenses) are equal to total revenues. It is calculated using the formula:

$$BEV_INT = \frac{\text{fixed costs} + \text{interest}}{\text{price} - \text{variable cost}}$$

Investment Driven Break-Even (BEV_INV)

The investment breakeven point takes into account any debt servicing costs and the required equity return of the enterprise - it is defined as the threshold where total operating costs (variable, fixed, debt servicing expenses and the required equity return of the enterprise) are equal to total revenues. It is calculated using the formula:

$$BEV_INV = \frac{\text{fixed costs} + \text{interest} + \text{equity return}}{\text{price} - \text{variable cost}}$$

DEPRECIATION MODE

This mode lets you calculate the following (in all cases, a graph and accompanying table showing the results is shown - the table can be saved to the sd card in csv format by pressing the Export Table button):

Straight-Line Method (SL)

Using the straight-line method, the depreciation of an asset is spread evenly across its life based on the difference between the original cost and the salvage value of the asset.

Fixed-Percentage Method (FP)

Using the fixed-percentage method, the depreciation of an asset is calculated using a fixed percentage on the declining balance across its life with no account being taken for any salvage value.

Sum-of-Years-Digits Method (SYD)

The sum-of-years-digits method is an accelerated method for calculating the depreciation of an asset. This method takes the expected life of the asset and adds together the digits for each year. Each digit is then divided by this sum to determine the percentage by which the asset should be depreciated each year, starting with the highest number in year 1.

Fixed-Declining-Balance Method (FDB)

Using the fixed-declining-balance method, the asset is depreciated using a depreciation rate calculated by the formula:

$$\text{rate} = 1 - \left(\frac{s}{c} \right)^{\frac{1}{l}}$$

where:

- s = salvage value
- c = original cost
- l = asset life

with an adjustment made in the last period, if necessary, to leave the end book value equal to the salvage value.

Declining-Balance Method (DB)

The declining-balance method is an accelerated method for calculating the depreciation of an asset which uses the straight-line depreciation percentage multiplied by a factor. This method does not consider the salvage value in the depreciation of each period however, if the book value falls below the salvage value in any period, the book value for that period (and any succeeding periods) is adjusted to the salvage value.

BOND MODE

This mode lets you calculate the following:

- [Purchase Price \(PRC\)](#)
- [Yield to Maturity \(YTM\)](#)
- [Yield to Call \(YTC\)](#)
- [Duration \(DUR\)](#)
- [Convexity \(CONVEX\)](#)

Purchase Price (PRC)

This mode calculates the bond price and any accrued interest that the bond seller may have earned for holding the bond for a period of time between bond payments. The formula used to calculate the bond price is:

$$PRC = \frac{C}{F} \times \left(1 - \frac{1}{\left(1 + \frac{i}{F}\right)^{nF}} \right) + \frac{M}{\left(1 + \frac{i}{F}\right)^{nF}}$$

where:

- C is the coupon payment
- F is the frequency of coupon payments (1 for annual or 2 for semi-annual)
- M is the value at maturity, or par value
- i is the required yield
- n is the number of payments

The accrued interest (AI) is calculated by the following formula:

$$AI = C \times \frac{x}{y}$$

where:

- C is the coupon payment
- x is the days between the sales date and the last coupon payment date
- y is the total days in the coupon payment period

Yield to Maturity (YTM)

This mode returns the rate of return on a bond if it is held until the maturity date. The app uses the Newton-Raphson Method to solve the equation

$$\sum_{i=0}^n \frac{C_i}{(1+r)^i} = 0$$

where:

- C_i is each cash flow with the first cash flow being the price paid (computed as a negative value), succeeding cash flows being the coupon rate \times the par value and with the final cash flow also including the par value
- n is the number of coupon payments + 1 (to include the initial cash outflow via the price paid)
- r is the unknown yield value

Yield to Call (YTC)

This mode returns the rate of return earned if a callable bond is purchased at its current market price and held it until the call date given that the bond was called on the call date. The app uses the Newton-Raphson Method to solve the equation

$$\sum_{i=0}^n \frac{C_i}{(1+r)^i} = 0$$

where:

- C_i is each cash flow with the first cash flow being the price paid (computed as a negative value), succeeding cash flows being the coupon rate \times the par value and with the final cash flow also including the call value
- n is the number of coupon payments + 1 (to include the initial cash outflow via the price paid)
- r is the unknown yield value

Duration (DUR)

The duration of a bond is the weighted average of the times until all its cash flows have been received. This mode returns both the Macaulay Duration (MacD) and the Modified Duration (MD) which are calculated using the following formulas:

$$\text{MacD} = \frac{\sum_{t=1}^n \frac{tC}{(1+y)^t} + \frac{nM}{(1+y)^n}}{P}$$

and

$$\text{MD} = \frac{\text{MacD}}{1 + \frac{\text{YTM}}{F}}$$

where:

- C is the coupon payment
- t is the respective time period
- y is the periodic yield
- n is the number of payment periods
- M is the value at maturity, or par value
- P is the current bond price
- YTM is the yield to maturity
- F is the frequency of coupon payments (1 for annual or 2 for semi-annual)

Convexity (CONVEX)

Convexity is a measure of the sensitivity of the duration of a bond to changes in interest rates and is calculated using the formula:

$$\text{CONVEX} = \frac{1}{P \times (1+y)^2} \times \sum_{t=1}^T \frac{C_t}{(1+y)^t} \times (t^2 + t)$$

where:

- P is the current bond price
- y is the yield to maturity
- T is the maturity in years
- C_t is the cash flow at time t

DAYS CALCULATION MODE

The app uses the ISO 8601 calendar system for years starting from 1583 and the GregorianJulian calendar system for years before 1583. This mode lets you calculate the following:

Days Between Dates (DAYS)

Two dates are entered and the number of days between those dates is returned.

Date After Days (DATE)

A date and the number of days are entered and the date after those days is returned.

Date Before Days (DATE_BEFORE)

A date and the number of days are entered and the date before those days is returned.

INTEREST CONVERSION MODE

This mode is dependent upon the C/Y settings and lets you convert the following:

Annual Nominal Rate (NOM) > EFF

NOM is converted to EFF using the formula:

$$EFF = \left(1 + \frac{i}{(100 \times C/Y)} \right)^{C/Y} - 1 \times 100$$

where i = NOM.

Annual Effective Rate (EFF) > NOM

EFF is converted to NOM using the formula:

$$NOM = \left(\left(1 + \frac{i}{100} \right)^{\frac{1}{C/Y}} - 1 \right) \times C/Y \times 100$$

where i = EFF.

OPTIONS TRADING (GREEKS)

This mode uses the Black–Scholes formula to determine the implied volatility of European put and call options - it then calculates the Greeks (delta, gamma, vega, theta and rho) as follows:

Black–Scholes Formula:

$$C = S \times e^{-YT} \times N(d_1) - X \times e^{-rT} \times N(d_2)$$

where $N(.)$ is the cumulative standard normal distribution with a mean of 0 and a standard deviation of 1 and

$$d_1 = \frac{\ln\left(\frac{S \times e^{-YT}}{X}\right) + \left(r + \frac{\sigma^2}{2}\right) \times T}{\sigma \times \sqrt{T}}$$

$$d_2 = \frac{\ln\left(\frac{S \times e^{-YT}}{X}\right) + \left(r - \frac{\sigma^2}{2}\right) \times T}{\sigma \times \sqrt{T}}$$

where:

- C is the option price
- S is the spot price
- X is the strike price
- r is the current risk-free interest rate
- Y is the dividend yield
- T is the time to expiration of the option (in years)
- σ is the implied volatility
- e is Euler's number
- \ln is the natural logarithm

delta - measures the rate of change of option value with respect to changes in the underlying asset's price - is the first derivative of the value C of the option with respect to the underlying asset's price S :

$$\text{Call: } \frac{\delta C}{\delta S} = N(d_1) \times e^{-YT}$$

$$\text{Put: } \frac{\delta C}{\delta S} = (N(d_1) - 1) \times e^{-YT}$$

gamma - measures the rate of change of option value with respect to changes in the underlying asset's price - is the second derivative of the value C of the option with respect to the underlying asset's price S :

$$\text{Call: } \frac{\delta^2 C}{\delta S^2} = \frac{N'(d_1) \times e^{-YT}}{S \times \sigma \times \sqrt{T}}$$

$$\text{Put: } \frac{\delta^2 C}{\delta S^2} = \frac{N'(d_1)}{S \times \sigma \times \sqrt{T}}$$

where $N'(.)$ is the standard normal distribution with a mean of 0 and a standard deviation of 1

vega - measures sensitivity to volatility - is the derivative of the option value with respect to the volatility of the underlying asset:

$$\frac{\delta C}{\delta \sigma} = \frac{N'(d_1) \times e^{-YT} \times S \times \sqrt{T}}{100}$$

where $N'(\cdot)$ is the standard normal distribution with a mean of 0 and a standard deviation of 1

theta - measures the sensitivity of the value of the option with respect to the passage of time:

$$\begin{aligned} \text{Call: } \frac{\delta C}{\delta t} &= \frac{-\frac{S \times N'(d_1) \times \sigma \times e^{-YT}}{2 \times \sqrt{T}} + Y \times S \times N(d_1) \times e^{-YT} - r \times X \times e^{-rT} \times N(d_2)}{365} \\ \text{Put: } \frac{\delta C}{\delta t} &= \frac{-\frac{S \times N'(d_1) \times \sigma \times e^{-YT}}{2 \times \sqrt{T}} - Y \times S \times N(-d_1) \times e^{-YT} + r \times X \times e^{-rT} \times N(-d_2)}{365} \end{aligned}$$

where $N'(\cdot)$ is the standard normal distribution with a mean of 0 and a standard deviation of 1 and
 $d_2 = d_1 - (\sigma \times \sqrt{T})$

rho - measures the sensitivity of the value of the option to the interest rate:

$$\begin{aligned} \text{Call: } \frac{\delta C}{\delta r} &= \frac{X \times T \times e^{-rT} \times N(d_2)}{100} \\ \text{Put: } \frac{\delta C}{\delta r} &= \frac{-X \times T \times e^{-rT} \times N(-d_2)}{100} \\ \text{where: } d_2 &= d_1 - (\sigma \times \sqrt{T}) \end{aligned}$$