VCE SPECIALIST MATHEMATICS UNITS 1 & 2 – ESSENTIAL CAS CALCULATOR SKILLS

INCL. WORKED EXAMPLES & AN END-OF-YEAR SKILLS CHECKLIST

Reference CAS calculator: Texas Instruments TI-Nspire CAS II

Contents

Topic chapters

Chapter 1: Reviewing Algebra: Chapter 4: Additional Algebra

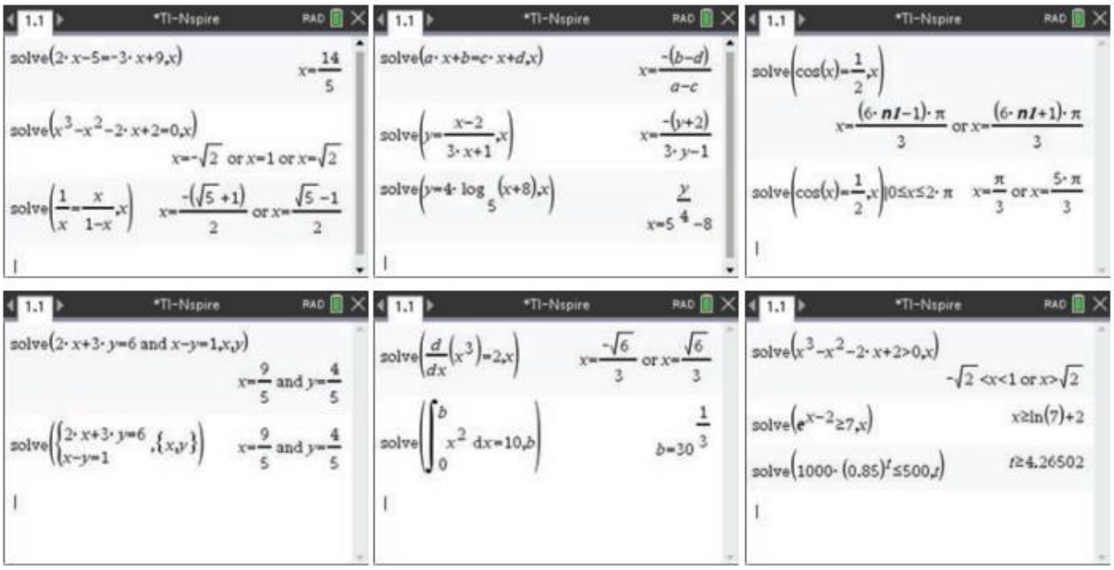
Solving equations

1: Solve

This command is used to solve equations, simultaneous equations and some inequalities.

An approximate (decimal) answer can be obtained by pressing (ctrl)(enter) or by including a decimal number in the expression.

The following screens illustrate its use.



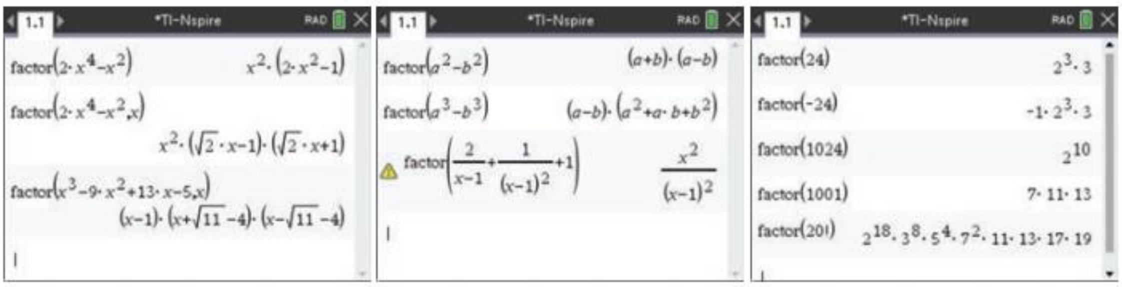
Factorising algebraic expressions and real numbers

2: Factor

This command is used for factorisation.

Factorisation over the rational numbers is obtained by not specifying the variable, whereas factorisation over the real numbers is obtained by specifying the variable.

The following screens illustrate its use.

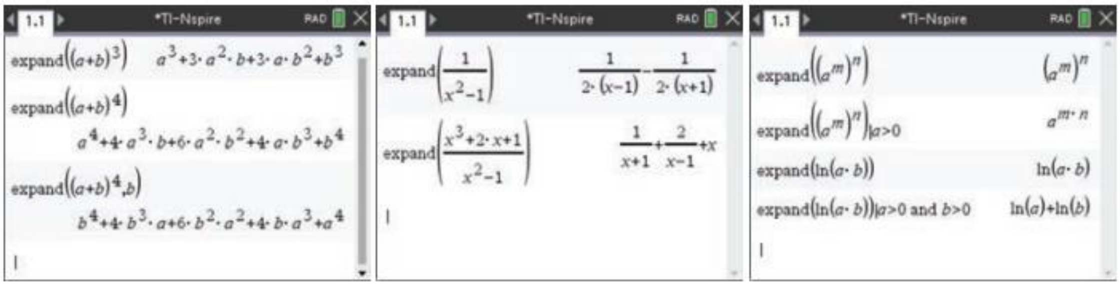


Expanding algebraic expressions

3: Expand

This command is used for expanding out expressions.

By specifying the variable, the expanded expression will be ordered in decreasing powers of that variable. Symbolic expressions can only be expanded for an appropriate domain.



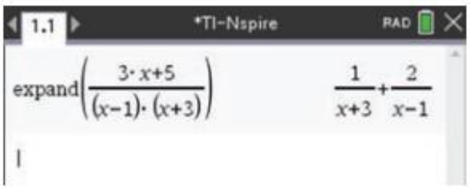
Resolving an algebraic expression into partial fractions

Q: Resolve $\frac{3x+5}{(x-1)(x+3)}$ *into partial fractions.*

A:

Use (menu) > **Algebra** > **Expand** as shown.

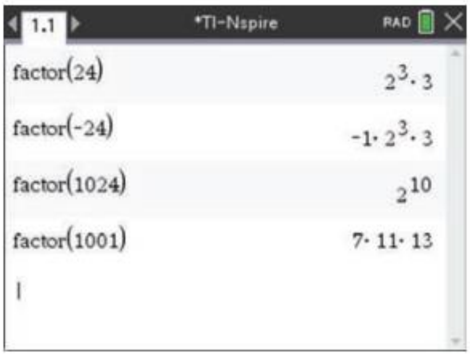
Note: You can access the fraction template using (ctrl) (÷).



Chapter 2: Number Systems and Sets

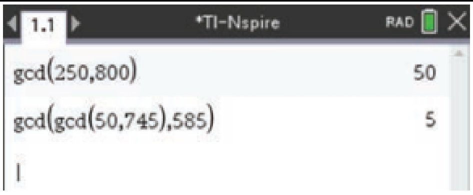
Finding the prime decomposition of a natural number

- The prime decomposition of a natural number can be obtained using (menu) > **Algebra** > **Factor** as shown.



Finding the highest common factors of two numbers

- The highest common factor of two numbers (also called their *greatest common divisor*) can be found by using the command **gcd( )** from (menu) > **Number** > **Greatest Common Divisor**, or by just typing it in, as shown.



Note: Nested **gcd( )** commands may be used to find the greatest common divisor of several numbers.

Finding the lowest common multiple of two numbers

Using the TI-Nspire

The lowest common multiple of two numbers (also called their *least common multiple*) can be found by using the command **lcm( )** from (menu) > **Number** > **Least Common Multiple**, or by just typing it in, as shown.

Chapter 3: Sequences and Series

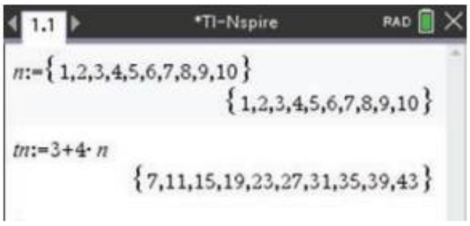
Generating the first *n* terms of an explicitly defined sequence of numbers

Q: Generate the first 10 terms of the sequence of numbers defined by the rule $t_n = 3 + 4n$.

A:

Sequences defined in terms of n can be investigated in a **Calculator** application.

- To generate the first 10 terms of the sequence defined by the rule $t_n = 3 + 4n$, complete as shown. The assignment symbol := is accessed using (ctrl) (⊞).



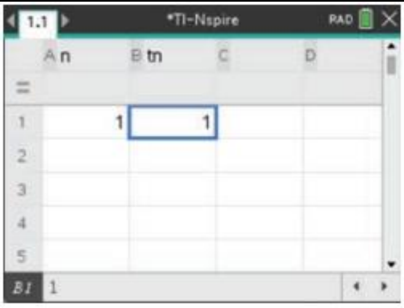
Note: Assigning (storing) the resulting list as tn enables the sequence to be graphed. If preferred, the variable tn can be entered as t_n using the subscript template □▫, which is accessed via (⊞).

Generating and graphing the first *n* terms of a recursively defined sequence of numbers

Q: Generate the sequence defined by the recurrence relation $t_n = t_{n-1} + 3$, $t_1 = 1$.

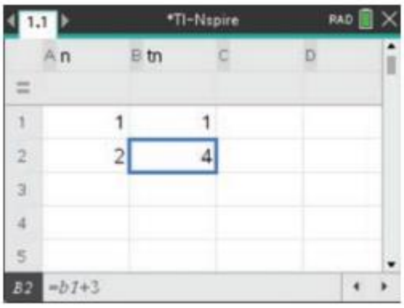
A:

- In a **Lists & Spreadsheet** page, name the first two lists n and tn respectively.
- Enter 1 in cell A1 and enter 1 in cell B1.

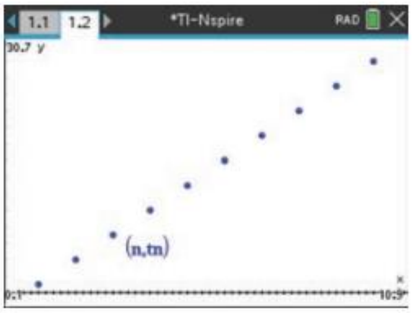


Note: If preferred, the variable tn can be entered as t_n using the subscript template □▫, which is accessed via (⊞).

- Enter $= a1 + 1$ in cell A2 and enter $= b1 + 3$ in cell B2.

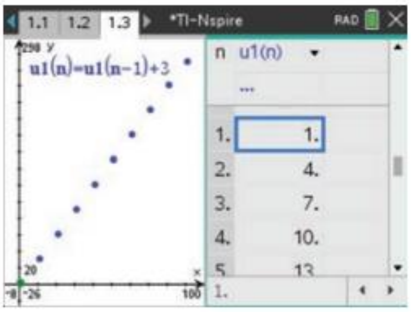


- To graph the sequence, open a **Graphs** application ((ctrl)(I) > **Add Graphs**).
- Graph the sequence as a scatter plot using (menu) > **Graph Entry/Edit** > **Scatter Plot**. Enter the list variables as n and tn in their respective fields.
- Set an appropriate window using (menu) > **Window/Zoom** > **Zoom – Data**.



Note: It is possible to see the coordinates of the points: (menu) > **Trace** > **Graph Trace**. The scatter plot can also be graphed in a **Data & Statistics** page.

- Alternatively, the sequence can be graphed directly in the sequence plotter ((menu) > **Graph Entry/Edit** > **Sequence** > **Sequence**).
- Enter the rule $u1(n) = u1(n-1) + 3$ and the initial value 1. Change **nStep** to 10.
- Set an appropriate window using (menu) > **Window/Zoom** > **Zoom – Fit**.
- Use (ctrl)(T) to show a table of values.



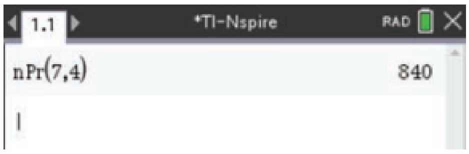
Chapter 9: Combinatorics

Evaluating permutations

Q: Evaluate $^{7}P_{4}$.

A:

- To evaluate $^{7}P_{4}$, use (menu) > **Probability** > **Permutations** as shown.



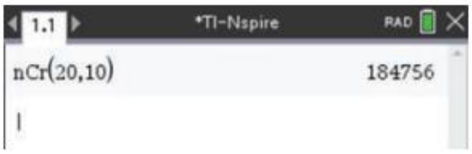
Note: Alternatively, you can simply type npr(7, 4). The command is not case sensitive.

Evaluating combinations

Q: Evaluate $^{20}C_{10}$.

A:

- To evaluate $^{20}C_{10}$, use (menu) > **Probability** > **Combinations** as shown.



Note: Alternatively, you can simply type ncr(20, 10). The command is not case sensitive.

Performing arithmetic operations on matrices

Entering matrices

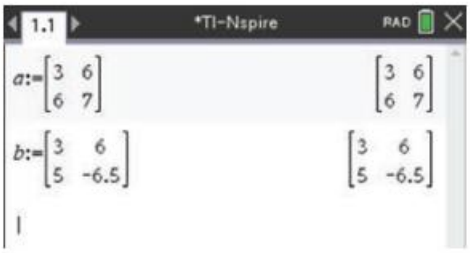
Assign the matrix $\mathbf{A} = \begin{bmatrix} 3 & 6 \\ 6 & 7 \end{bmatrix}$ as follows:

- In a **Calculator** page, type $a :=$ and then enter the matrix. (The assign symbol := is accessed using ctrl ⊞.)
- The simplest way to enter a 2×2 matrix is by using the 2×2 matrix template as shown. (Access the templates using either ⊞ or ctrl menu > **Math Templates**.)

Note: There is also a template for entering $m \times n$ matrices.

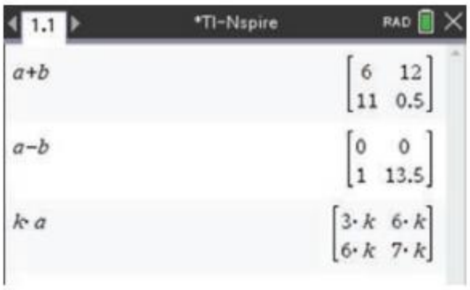
- Use the touchpad arrows (or tab) to move between the entries of the matrix.

Assign the matrix $\mathbf{B} = \begin{bmatrix} 3 & 6 \\ 5 & -6.5 \end{bmatrix}$ similarly.



Operations on matrices

Once $\mathbf{A}$ and $\mathbf{B}$ are assigned as above, the matrices $\mathbf{A} + \mathbf{B}$, $\mathbf{A} - \mathbf{B}$ and $k\mathbf{A}$ can easily be determined.



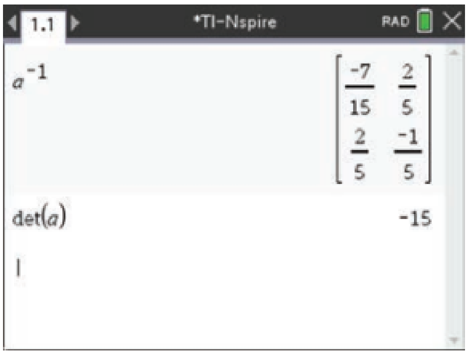
Finding the inverse and the determinant of a matrix

Q: For $A = \begin{bmatrix} 3 & 6 \\ 6 & 7 \end{bmatrix}$, *find* A^{-1} *and* $\det(A)$.

A:

- The inverse of a matrix is obtained by raising the matrix to the power of -1.
- The determinant command (menu > **Matrix & Vector** > **Determinant**) is used as shown.

Hint: You can also type in det(a).

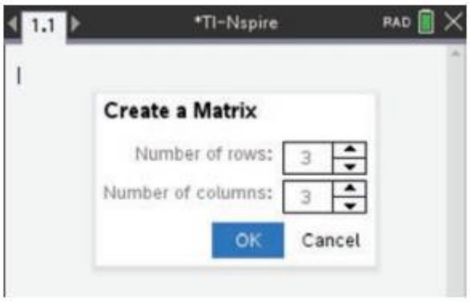


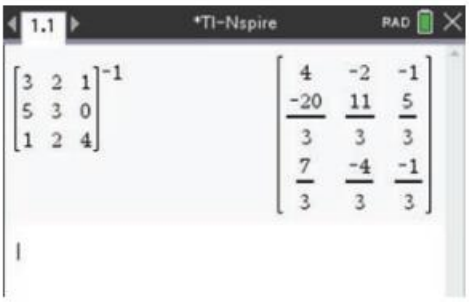
(Here a is the matrix $\mathbf{A} = \begin{bmatrix} 3 & 6 \\ 6 & 7 \end{bmatrix}$ defined in Section 11B.)

Q: Find the inverse of the matrix $\begin{bmatrix} 3 & 2 & 1 \\ 5 & 3 & 0 \\ 1 & 2 & 4 \end{bmatrix}$.

A:

- To enter a 3×3 matrix, select the m-by-n matrix template [template]. (The templates can be accessed using [template key].) Complete the pop-up screen as shown below.
- The inverse of a matrix is obtained by raising the matrix to the power of -1.

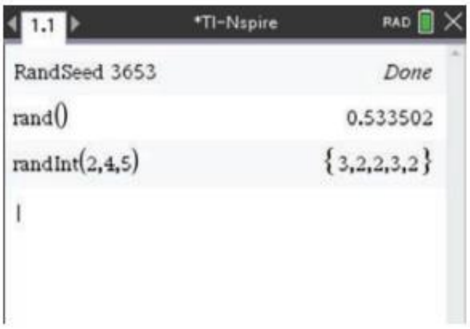




Chapter 14: Simulation, Sampling and Sampling Distributions

Generating random numbers

- In a **Calculator** page, go to (menu) > **Probability** > **Random** > **Seed** and enter the last 4 digits of your phone number. This ensures that your random-number starting point differs from the calculator default.
- For a random number between 0 and 1, use (menu) > **Probability** > **Random** > **Number**.



- For a random integer, use (menu) > **Probability** > **Random** > **Integer**. To obtain five random integers between 2 and 4 inclusive, use the command randInt(2, 4, 5) as shown.

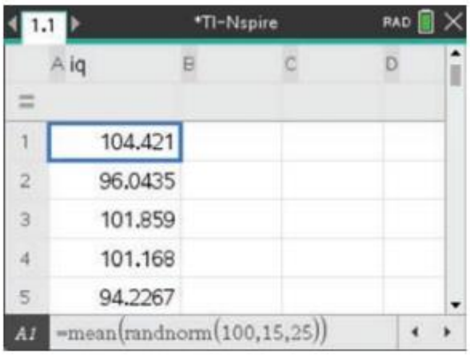
Simulating samples from a normal distribution

Q: Generate the sample means for 10 random samples of size 25 from a normal population with mean 100 and standard deviation 15.

A:

To generate the sample means for 10 random samples of size 25 from a normal population with mean 100 and standard deviation 15:

- Start from a **Lists & Spreadsheet** page.
- Name the list 'iq' in Column A.
- In cell A1, enter the formula using (menu) > **Data** > **Random** > **Normal** and complete as: = mean(randnorm(100, 15, 25))
- Use (menu) > **Data** > **Fill** to fill down to obtain the sample means for 10 random samples.

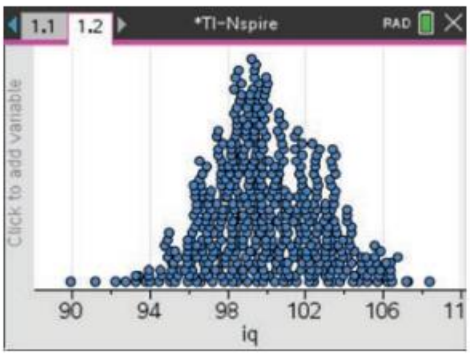


For a large number of simulations, an alternative method is easier.

To generate the sample means for 500 random samples of size 25, enter the following formula in the formula cell of Column A:

= seq(mean(randnorm(100, 15, 25)), k, 1, 500)

The dotplot on the right was created this way.



Chapter 17: Graphing Functions and Relations

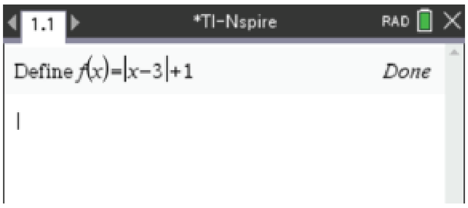
Graphing modulus equations

Q: Graph the equation $y = |x - 3| + 1$.

A:

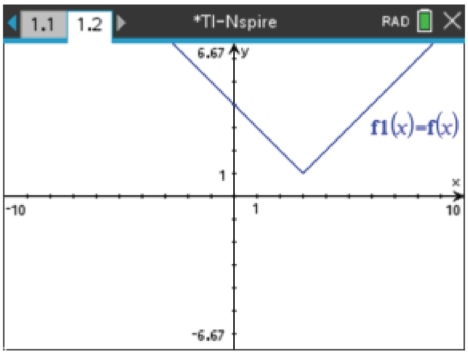
- Use (menu) > **Actions** > **Define** to define the function $f(x) = \text{abs}(x - 3) + 1$.

Note: The absolute value function can be obtained by typing **abs( )** or using the 2D-template palette.



- Open a **Graphs** application ((ctrl)(I) > **Graphs**) and let $f1(x) = f(x)$.
- Press (enter) to obtain the graph.

Note: The expression $\text{abs}(x - 3) + 1$ could have been entered directly for $f1(x)$.

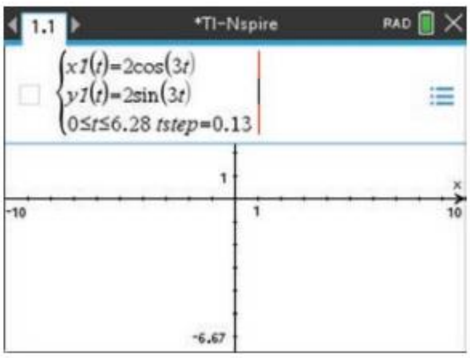


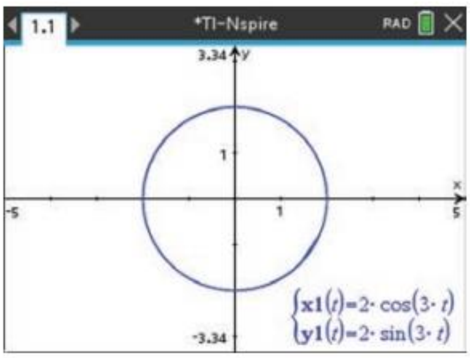
Graphing parametric equations

Q: Plot the graph of the parametric curve given by $x = 2\cos(3t)$ *and* $y = 2\sin(3t)$.

A:

- Open a **Graphs** application ((on) > **New Document** > **Add Graphs**).
- Use (menu) > **Graph Entry/Edit** > **Parametric** to show the entry line for parametric equations.
- Enter $x1(t) = 2\cos(3t)$ and $y1(t) = 2\sin(3t)$ as shown.

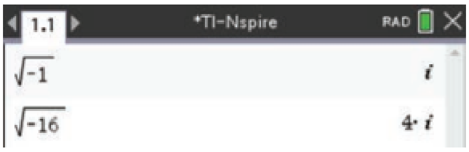




Chapter 18: Complex Numbers

Setting a CAS calculator to incorporate complex numbers

Set to complex mode using (on) > **Settings** > **Document Settings**. Select **Rectangular** from the **Real or Complex** field.

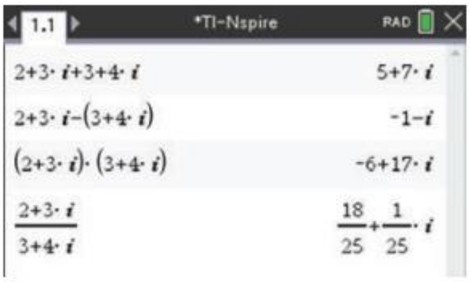


Note: The square root of a negative number can be found only in complex mode. But most computations with complex numbers can also be performed in real mode.

Performing arithmetic operations on complex numbers

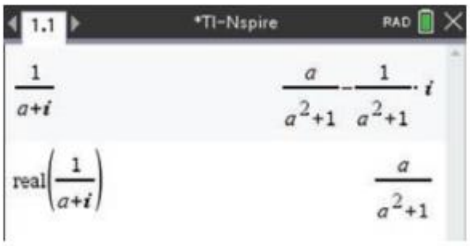
- The results of the arithmetic operations $+$, $-$, $\times$ and $\div$ are illustrated using the two complex numbers $2 + 3i$ and $3 + 4i$.

Note: Do not use the text i for the imaginary constant. The symbol i is found using (π▸) or the Symbols palette ((ctrl)(📖)).



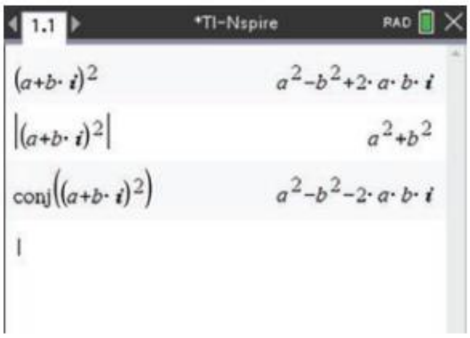
Finding the real part of a complex number

- To find the real part of a complex number, use (menu) > **Number** > **Complex Number Tools** > **Real Part**. Alternatively, type real(.



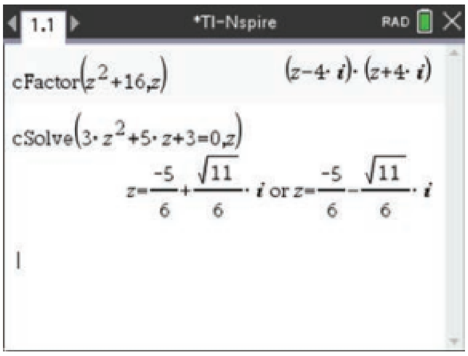
Finding the modulus and the conjugate of a complex number

- To find the modulus of a complex number, use (menu) > **Number** > **Complex Number Tools** > **Magnitude**. Alternatively, use |□| from the 2D-template palette (⊞) or type abs(.
- To find the conjugate of a complex number, use (menu) > **Number** > **Complex Number Tools** > **Complex Conjugate**. Alternatively, type conj(.



Factorising polynomial expressions and solving polynomial equations over complex numbers

- To factorise polynomials over the complex numbers, use (menu) > **Algebra** > **Complex** > **Factor** as shown.
- To solve polynomial equations over the complex numbers, use (menu) > **Algebra** > **Complex** > **Solve** as shown.



Summary of essential skills

Topic chapter	By the end of this chapter, you should be able to do the following using a CAS calculator:
1: Reviewing Algebra; 4: Additional Algebra	• Solve algebraic equations • Factorise algebraic expressions • Expand algebraic expressions • Resolve an algebraic expression into partial fractions • Solve simultaneous polynomial equations involving 2-3 unknown variables
2: Number Systems and Sets	• Find the prime decomposition of a natural number • Find the highest common factor and lowest common multiple of two numbers
3: Sequences and Series	• Generate the first *n* terms of an explicitly defined sequence of numbers • Generate the first *n* terms of a recursively defined sequence of numbers
6: Proof	N/A
7: Logic	N/A
8: Algorithms	*See "Appendix D: Introduction to coding using the TI-Nspire" in the Interactive version of the Cambridge textbook
9: Combinatorics	• Evaluate permutations and combinations
11: Matrices	• Perform arithmetic operations on matrices • Find the inverse and the determinant of a matrix
12: Graph Theory	N/A
14: Simulation, Sampling and Sampling Distributions	• Generate random numbers • Simulate samples from a normal distribution
15: Trigonometric Ratios and Applications; 16: Trigonometric Identities	• Solve trigonometric equations
17: Graphing Functions and Relations	• Graph modulus equations • Graph parametric equations
18: Complex Numbers	• Set your CAS calculator to complex mode • Perform arithmetic operations on complex numbers • Find the real part of a complex number • Find the modulus of a complex number • Find the conjugate of a complex number • Factorise polynomial expressions over complex numbers • Solve polynomial equations over complex numbers
20: Transformations of the Plane	• Perform operations on matrices
21: Vectors in the Plane	N/A
23: Kinematics	N/A

Appendix: List of useful TI-Nspire CAS calculator shortcuts

Shortcut	Function
Ctrl + A	Select all
Ctrl + C	Copy
Ctrl + H	Find and replace
Ctrl + K	Select page (in split screen)
Ctrl + N	New document
Ctrl + O	Open document
Ctrl + R	Recalculate
Ctrl + S	Save document
Ctrl + V	Paste
Ctrl + W	Close current document
Ctrl + X	Cut
Ctrl + Y	Redo
Ctrl + Z	Undo
Ctrl + 1	Move to end of list/page down
Ctrl + 3	Page down
Ctrl + 4	Merge two pages into split screen
Ctrl + 7	Move to top of list/page up
Ctrl + 6	Convert split screen into two pages
Ctrl + 9	Page up
Ctrl + space	Underscore
Ctrl + tab	Toggle between split screen windows
Ctrl + tab	Toggle between open documents
Shift + (-)	Derivative
Shift + +	Integral
Shift + arrows	Highlight selected text
Shift + esc	Redo