How to Use Your TI-89 to Solve Problems With Complex Numbers

I. Mode key is important! There are 3 different settings in it you must use.
   A. Mode key: Scroll down and ALWAYS use "approx" never "exact" (which unfortunately is on by default).
   B. Complex numbers are typically written in rectangular notation (e.g. 4+3i) or polar (e.g. 5∠30°). Under the Mode key is a Complex Format option that can be either in rectangular or polar notation – this governs the form of the answer. For phasors, you usually want to specify polar.
   C. If you are viewing complex numbers in polar form, you may use units of degrees or radians for phase, set by the Mode – Angle option. This will set both the INPUT units and the OUTPUT units.
      1. Input: Entering (3 ∠ 2) will be interpreted as having a phase of 2 radians or 2 degrees, depending on the angle mode
      2. Output: If the mode is Complex Format = Polar and Angle = Degrees, a phasor of 4∠20° will be displayed as 4∠20 (makes sense). If Angle = Radians, 4∠0.8 is displayed in Complex Exponential format as $4e^{0.8i}$ (probably not what you expected!) but you can see how to re-write it as 4∠0.8 .

II. Simple Examples
   A. Find 2+j6 in polar notation using degrees
      Solution: Mode-Complex Format-polar, Mode-Angle-Degrees
         Enter: 2+i6.
         Calculator's answer: (6.32∠71.6)
         Your answer: 6.32∠71.6°
   B. Find (2+j6)(3∠5°)/(2∠0.8 radians) in polar notation using degrees
      Solution: This tricky because one angle is in degrees, the other in radians. Convert the one in radians to rectangular first, then sub that in the rest of the equation.
         Mode-Complex Format-Rectangular, Mode-Angle-Radians
         Enter: (2∠0.8) note: unlike rectangular, you **must** enclose polar notation inside parentheses!
         Calculator's answer: 1.393 + 1.435 i
         Mode-Complex Format-Polar, Mode-Angle-Degrees
         Enter: (2+6i)(3∠5)/(1.393 + 1.435 i)
         Calculator's answer: (9.49∠30.7)
         Your answer: 9.49∠30.7°

III. Complex Matrix Solving by Example
   Solve: $V_1(2\angle 30°) + V_2(2+j6) = j3$, $V_1 + V_2(2\angle 200°) = j$
   Solution
      1. Put your calculator in the correct mode: Mode-Complex Format-Polar, Mode-Angle-Degrees

      2. `cSolve((2∠30)x + (2+6i)y = 3i and x + (2∠200)y = i, {x, y})`

      To type "cSolve", engage alpha lock (2^{nd}, alpha) and type the letters directly (e.g. "c" is above the ")" key). Enter capitals in alpha mode by first pressing the ⇧ key (to the right of the "2^{nd}" key). The word "and" must be typed; use the ␣ key (i.e. ⇧ (-)) to put spaces on either side of it. The curly brackets tell the calculator what variables to solve for. We use x for V_1 and y for V_2 since they have dedicated keys. If your calc errors with "non-algebraic values" use variables a and b instead of x and y (some OS versions do this).

      Calculator answer: x = 1.09∠73.3, y = 0.159∠-11.5
      Your answer: V_1 = 1.09∠73.3°, V_2 = 0.159∠-11.5°

How to Use Your TI-NSpire to Solve Problems With Complex Numbers

I. You want to direct the calculator to compute complex answers, in either rectangular notation for impedance phasors (e.g. an answer may be 2+5i ohms) or polar notation in degrees for voltage or current phasors (e.g. an answer may be $4\angle 60°$ Volts).
   A. **To set to rectangular mode**: DOC▼ → 7:Settings & States → 2: Document Settings. Set "Real or Complex" to Rectangular, and "Calculation Mode" to Approximate, and make this the default.
   B. **To set to polar mode**: DOC▼ → 7:Settings & States → 2: Document Settings. Set "Angle" to Degree, "Real or Complex" to Polar, and "Calculation Mode" to Approximate, and make this the default.
   C. If you are viewing complex numbers in polar form, the settings for Angle of Degrees or Radians sets both the INPUT units and the OUTPUT units.
      1. Input: Entering $(3 \angle 2)$ is interpreted as having a phase of 2 rads or 2°, depending on the angle mode
      2. Output: If the mode is Degrees, a phasor of $4\angle 20°$ will be displayed as $4\angle 20$ (makes sense). If Angle = Radians, $4\angle 0.8$ is displayed in Complex Exponential format as $4e^{0.8i}$ (probably not what you expected!) but you can see how to re-write it as $4\angle 0.8$.

II. Simple Examples
   A. Find 2+j6 in polar notation using degrees
      Solution: Mode-Complex Format-polar, Mode-Angle-Degrees
         Enter: 2+i6.
         Calculator's answer: $(6.32\angle 71.6)$
         Your answer: $6.32\angle 71.6°$
   B. Find $(2+j6)(3\angle 5°)/(2\angle 0.8$ radians) in polar notation using degrees
      Solution: This tricky because one angle is in degrees, the other in radians. Convert the one in radians to rectangular first, then sub that in the rest of the equation.
         Mode-Complex Format-Rectangular, Mode-Angle-Radians
         Enter: $(2\angle 0.8)$ note: unlike rectangular, you **must** enclose polar notation inside parentheses!
         Calculator's answer: 1.393 + 1.435 i
         Mode-Complex Format-Polar, Mode-Angle-Degrees
         Enter: $(2+6i)(3\angle 5)/(1.393 + 1.435 i)$
         Calculator's answer: $(6.32\angle 30.7)$
         Your answer: $6.32\angle 30.7°$

III. Complex Matrix Solving by Example
   Solve: $V_1(2\angle 30°) + V_2(2+j6) = j3$, $V_1 + V_2(2\angle 200°) = j$
   Solution
      1. Put your calculator in the correct mode: Mode-Complex Format-Polar, Mode-Angle-Degrees

      2. `cSolve((2∠30)x + (2+6i)y = 3i and x + (2∠200)y = i, {x, y})`

      To type "cSolve", engage alpha lock (2^{nd}, alpha) and type the letters directly (e.g. "c" is above the ")" key). Enter capitals in alpha mode by first pressing the ⇧ key (to the right of the "2^{nd}" key). The word "and" must be typed; use the ␣ key (i.e. ⇧ (-)) to put spaces on either side of it. The curly brackets tell the calculator what variables to solve for. We use x for V_1 and y for V_2 since they have dedicated keys. If your calc errors with "non-algebraic values" use variables a and b instead of x and y (some OS versions do this).

      Calculator answer: $x = 1.09\angle 73.3$, $y = 0.159\angle -11.5$
      Your answer: $V_1 = 1.09\angle 73.3°$, $V_2 = 0.159\angle -11.5°$

Example: find the impedance of (8-j6) in parallel with j10

Solution: First put calculator (either TI-89 or NSpire) into degree, rectangular, approximate modes

Method 1

$$\frac{1}{\frac{1}{8-j6}+\frac{1}{j10}}$$

1 / ((1 / (8 – 6 *i*) + 1 / (10 *i*)))

⇨ 10 + 5 *i*

Method 2

$$\frac{(8-j6)(j10)}{(8-j6)+j10}$$

((8 – 6 *i*) (10 *i*)) / (8 + 4 *i*)

⇨ 10 + 5 *i*