EE210 – Circuits
Complex Numbers and Your Calculator

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This is a work in progress. If you have a different calculator or software package you would like to see included, let me know. Thanks!!!

Let's explore evaluating the following complex number expression on a variety of calculators:

$$\frac{\left(\left(240\angle 75^{o}\right)+\left(160\angle -30^{o}\right)\right)\left(60-j\,80\right)}{\left(67+j\,84\right)\left(20\angle 32^{o}\right)}$$

Texas Instruments – TI83/84

In the MODE menu set the default angle unit to **Degrees** and the default complex format to **a+bi** (rectangular) mode. These calculators allow you to directly enter the imaginary unit *i*. (This is NOT the same as the alphabetic i key that is also available). They do not allow you to enter complex numbers in polar form. You must use exponential mode instead. *Angles in exponential mode can only be entered in radians*. Fortunately the calculator will convert from degrees to radians for you if you divide an angle in degrees by 1^{r} (one radian). The radian symbol (^{r}) can be found in the **Angle** menu. So to enter, for example, the polar form number $\left(240\angle 75\right)$ into the calculator you must enter 240 *e*^(*i* 75/1^{r}). The calculator will then display 62.12 + 231.8*i* corresponding to the polar form number $\left(240\angle 75\right)$.

Note: This conversion is only done correctly when the calculator is **Degrees** mode. Only in **Degrees** mode is 1^{r} converted to the number of degrees per radian. If the calculator is in **Radians** mode, then when 240 *e*^(*i* 75/1^{r}) is entered, the 75 is interpreted as radians. Always check to ensure that the calculator is in **Degrees** mode.

You can enter the expression above and assign the result to variable **Z** with the following command:

(240 *e*^(*i*75/1^{r})+160 *e*^(-*i*30/1^{r})) (60 – *i*80)/((67 + *i*84) 20 *e*^(*i*32/1^{r})) → Z

The calculator then displays:

-1.922 – 11.551 *i*

Use the ►**Polar** conversion operation from the complex menu (MATH → CPX) to display the polar form magnitude and angle:

Z►Polar
11.710e^(-99.445i)

The equivalent polar form number is therefore $\left(11.710\angle -99.445\right)$.

Note: The TI 83/84 has what I consider to be a bug in its handling of complex numbers. When in **Degrees** mode a complex number displayed in Polar form (really exponential) will show the angle in degrees. If you enter the number as displayed (without dividing by 1^{r}) the angle will be interpreted as being in radians.

Texas Instruments – TI85/TI86

In the MODE menu set the default Angle unit to DEGREE and the default Complex Format to POLAR. You must enclose complex numbers expressed in polar form in parentheses. A number in rectangular form is entered as (R, I) where R and I are the real and imaginary parts of the number. To enter a complex number representing *i*, enter (0,1) or $(1\angle 90)$.
When entered in the calculator the expression above looks like this:

$$(((240\angle 75)+(160\angle -30))(60,-80))/((67,84)(20\angle 32))$$

The calculator then displays:

$$(11.710\angle -99.445).$$

The ►Rect operator can be used to convert complex numbers to rectangular form, applying this operator to the previous result gives:

-1.922 – 11.551 *i*

Texas Instruments – TI36XPro/TI89/TI92/Voyage 200

In the MODE menu set the default Angle unit to DEGREE and the default Complex Format to POLAR. You must enclose complex numbers expressed in polar form in parentheses. These calculators allow you to directly enter the imaginary unit *i*. (This is NOT the same as the alphabetic i key that is also available).

When entered in the calculator the expression above looks like this:

$$(((240\angle 75)+(160\angle -30))(60-i\,80))/((67+i\,84)(20\angle 32))$$

The calculator then displays:

$$(11.710\angle -99.445).$$

The ►Rect operator can be used to convert complex numbers to rectangular form, applying this operator to the previous result gives:

-1.922 – 11.551 *i*