

Complex Math Operations on the TI83+ Calculator

(Keith Hoover, December 8, 2005)

1. So our TI83+ calculators all behave the same way in this class, please set the mode of your calculator as follows: Note that all keys (besides numeric keys) on your calculator are bracketed by “< >” in this document.

Note that some of the indicated keys, require two keys to be pressed. For example the <i> key requires the yellow “2nd” key (leftmost key in top row) to be pressed followed by the “.” key (bottom row, 3rd from the right). Likewise, any alphabetic key, such as “A” requires the green “ALPHA” key to be pressed before the alphabetic key is pressed.

Start by pressing the <ON> button if the calculator is not on, and then pressing the <MODE> key. Use the cursor arrows and the <ENTER> key to select the following options:

Normal Sci Eng

Float 0 1 2 **3** 4 5 6 7 8 9

Radian Degree

Func Par **Pol** Seq

Connected Dot

Sequential Simul

Real a+bi **re^0i**

Full Horiz G-T

Press the <CLEAR> key to exit the setup mode and return to a blank calculator screen. These defaults should not go away when you turn off your calculator; so theoretically, you will only have to set them once at the beginning of the quarter!

2. Find the phasor representation of $v_a(t) = 10\cos(20t + 30^\circ)$ Volts.

Solution: By inspection, thus the phasor representation of the sinusoid $v_a(t)$ is $\mathbf{V_a} = 10\exp(j30^\circ)$. (*Instead of boldface, please use an overbar to indicate phasor quantities when you are writing phasors by hand!*) To enter this into your TI83+, enter

10 <e^x> <i> 30 < π > < \div > 180 <)> <Enter>

Note that we must enter $j = \sqrt{-1}$ as “i”, and that there is a special calculator key for this. The multiplication sign is optional when multiplying two dissimilar quantities, such as “i” times the phase angle, so I have left it out. When using the exponentiating function key “e^x”, with an imaginary phase angle, as we are here, the phase angle must always be expressed in radians, thus we must convert the given 30 degree angle into radians using the standard technique of multiplying it by $\pi/180$.

You should now see the following two lines on your calculator display:

10e^(i30 π /180)
10.000e^(.524i)

You may convert this complex number from polar to rectangular form by entering:

<MATH> <CPX> <6: Rect> <ENTER> <ENTER>

The displayed result is:

Ans > Rect
8.660+5.000i

To store this complex number in our calculator as variable “A” (we may assign up to 27 real or complex variables using one-letter variable names from A to Z), so that it can later be retrieved without having to manually re-enter it, enter

<STO> <A> <ENTER>

The displayed result is

Ans > A
20.000e^{^(.524i)}

To recall this number at a later date, you may type

<RCL> <A> <ENTER>

3. Find the phasor representation of $v_b(t) = 5\sin(20t + 30^\circ)$ Volts.

Solution: Since $v_b(t)$ is expressed as a sine function, rather than as a cosine function, we must first use the trig identity $\sin(x) = \cos(x - 90^\circ)$. **Please memorize this trig identity, as it will be needed often in this course!**

Thus $v_b(t) = 5\cos(20t + 30^\circ - 90^\circ) = 5\cos(20t - 60^\circ)$, and $\mathbf{V}_b = 5\exp(-j60^\circ)$. Thus we must enter

5 <e^x> <i> <(-)> 60 < π > < \div > 180 <)> <Enter>

Note that when entering negative numbers, such as here we enter -60, you must use the negation key <(-)>, which is different from the subtraction key <->.

To store it as variable “B”, enter

<STO> <ENTER>

4. Find $v_a(t) + v_b(t)$ using phasor addition. Because we have previously stored \mathbf{V}_a as Variable A, and \mathbf{V}_b as Variable B, simply enter:

<A> <+> <ENTER>

The result should be displayed on the calculator as

$$A+B$$

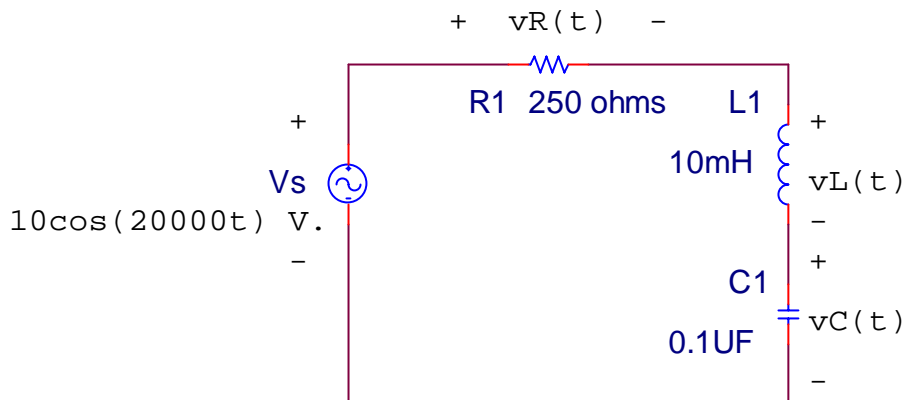
$$11.180e^{(0.060i)}$$

Thus, taking this result back to the time domain yields

$$v_a(t) + v_b(t) = 11.180\cos(20t+0.060 \text{ radians})$$

Of course, we can multiply the phase angle 0.060 radians by $180/\pi$ to get 3.438° if we desire to express the phase in degrees, but if you do this, please be sure to include the degrees symbol on the phase. If there is no symbol after the phase value, it will be assumed to be in radians.

5. Given that $v_s(t) = 10\sin(20000t)$ volts, $R = 250$ ohms, $L = 10$ mH, and $C = 0.1$ μ F, find $v_C(t)$, $v_L(t)$, and $v_R(t)$ using phasor analysis in the following circuit:



Solution:

Store inductive impedance in variable "L":

`<i> 20000 <x> 10 <EE> <(-)> 3 <ENTER> <STO> <L> <ENTER>`

Store capacitive impedance in variable "C":

`1 <÷> <(> <i> 20000 <x> 0.1 <EE> <(-)> 6 <)> <ENTER> <STO> <C> <ENTER>`

Calculate current "I", and store this in variable "I"

`10 <÷> <(> 250 <+> <L> <+> <C> <)> <ENTER>`
`<STO> <ALPHA> <I> <ENTER>`

Calculate V_R

`250 <x> <I> <ENTER>`

Answer: $6.402e^{(0.876i)} \Rightarrow$

$$v_R(t) = 6.402\cos(20000t + 0.876) \text{ Volts}$$

Calculate V_L

<L> <x> <I> <ENTER>

Answer: $5.121e^{(2.447i)} \Rightarrow$

$$v_L(t) = 5.121\cos(20000t + 2.447) \text{ Volts}$$

Calculate V_C

<C> <x> <I> <ENTER>

Answer: $12.804e^{(-0.695i)} \Rightarrow$

$$v_C(t) = 12.804\cos(20000t - 0.695) \text{ Volts}$$