Remedial Class on Solving Complex Quantities (Transformer circuit)

Transformer coil impedance $R_{eq} + jX_{eq}$

Transformer magnetic branch (shunt branch) impedance $Z_m = \frac{1}{Y_m}$ ← admittance.

where $Y_m = G_c + S_m$

↳ conductance (core) $= \frac{1}{r_c}$

↳ Susceptance $= \frac{1}{jx_m}$

Now these quantities are similare to complex quantities and all the applicable laws of complex algebra are applicable here.

For your ready reference

A Complex quantity $a+jb$ can be expressed in several ways:—

(1) $(a+jb)$ Rectangular form, a is real, b is imaginary

or

(2) $|a+jb| \angle\theta$ where $|a+jb| = \sqrt{a^2+b^2}$ and $\theta = \tan^{-1}\frac{b}{a}$ this is angular form

(3) $A(\cos\theta + j\sin\theta)$ → Trigonometrical form

or $A = \sqrt{a^2+b^2}$ and $\theta = \tan^{-1}\frac{b}{a}$

(4) $Ae^{j\theta}$ → Exponential form

where $A = \sqrt{a^2+b^2}$. $\theta = \angle\tan^{-1}\frac{b}{a}$

(2) It is convenient to devide and multiply quantities in Angular form as

$$A\angle\theta_1 \times B\angle\theta_2 = AB\angle\theta_1+\theta_2$$

$$\text{and } \frac{A\angle\theta_1}{B\angle\theta_2} = \frac{A}{B}\angle\theta_1-\theta_2$$

It is convenient to add and Substract quantities in rectangular form as

$$(A_1+jB_1)+(A_2+jB_2)$$
$$=(A_1+A_2)+j(B_1+B_2)$$

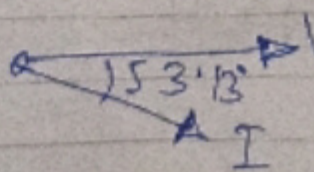
$$\text{and } (A_1+jB_1)-(A_2+jB_2)$$
$$=(A_1-A_2)-j(B_1-B_2)$$

If Voltage is given 415 volts means it is 415 volts RMS and to be taken as reference (so its angle is zero)

$$V=415\angle0^\circ = 415(\cos0^\circ+j\sin0)$$
$$=415(1+j0)\ V.$$

$$Z=3+j4\ \Omega = \sqrt{3^2+4^2}\angle\tan^{-1}\frac{4}{3} = 53.13^\circ$$

Find current I, $I=\frac{V}{Z}=\frac{415\angle0^\circ}{5\angle53.13}$



$$=83\angle0-53.13^\circ\ A \text{ (Angular}$$
$$=83(0.6-0.8j)$$
$$=49.8-j66.4\ A \text{ (Rectangular}$$

Question: The input impedance and current of a two terminal circuit are $\bar{V} = 10\angle 23.6^\circ$ V and $\bar{I} = 0.25\angle 65^\circ$ A

Find the circuit impedance and its components:

Solution:

The impedance in polar (angular) form

$$\bar{Z} = \frac{\bar{V}}{\bar{I}} = \frac{10\angle 23.6^\circ}{0.25\angle 65^\circ} = 40\angle -41.4^\circ\ \Omega$$

The above form can be converted

$$\bar{Z} = Re(40\angle -41.4^\circ) + j\,Im(40\angle -41.4^\circ)$$

$$\text{or } \bar{Z} = 40[\cos(-41.4) + j\sin(-41.4)]$$

$$= 40\angle -41.4^\circ$$

$$= 30 + j(-26.5)\ \Omega$$

So R = Real part = 30 Ω (Resistance)

X = Imaginary part = $-26.5\ \Omega$

(~~Inductive~~ Capacitive Reactance)

The above example is from Simple phasors It is taken here to illustrate the operation on Complex numbers which is awkward by many of you. Hope this topic is clear!!