Parallel AC Circuits

- Impedance and Admittance
  - Relationship and intro (**Z** and **Y**)
  - Admittance for the basic elements
  - Impedance and admittance diagram - Example
- Parallel Circuit Analysis
  - Example using impedance
  - Example using admittance
  - **ICP – Parallel AC Circuit**

Impedance and Admittance

RECALL : $\vec{Z} = R + jX$

IMPEDANCE ($\vec{Z}$), RESISTANCE (R), REACTANCE (X)

$$\vec{Y} \equiv \frac{1}{\vec{Z}} = \frac{1}{R + jX} \Rightarrow \text{FORM OF } G + jB$$

ADMITTANCE ($\vec{Y}$) ($\mho$ OR S)

CONDUCTANCE (G) ($\mho$) OR (S)

SUSCEPTANCE (B) ($\mho$ OR S)

A pure

RESISTANCE $\vec{Z} = R + j0$

$$\therefore \vec{Y} = 1/\vec{Z} = 1/R = G \ \mho$$

Impedance and Admittance

A pure

<u>INDUCTANCE</u>

$$\vec{Z}_L = 0 + jX_L$$

$$\therefore \vec{Y}_L = 1/\vec{Z}_L = \frac{1}{jX_L} = \boxed{\frac{-j}{X_L} = \underbrace{\left(\frac{1}{X_L}\right)}_{B_L} \angle -90^\circ} \mho$$

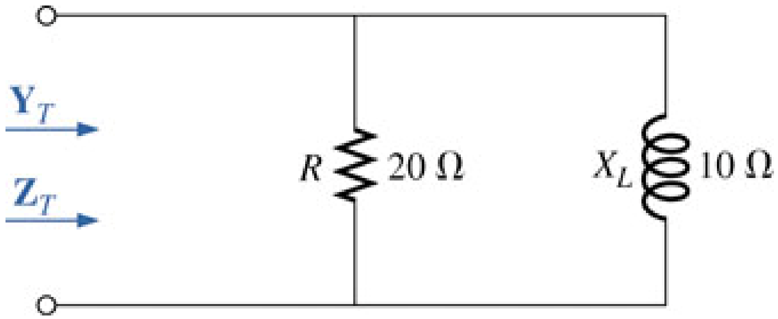
A pure

<u>CAPACITANCE</u>

$$\vec{Z}_C = 0 - jX_C$$

$$\therefore \vec{Y}_C = 1/\vec{Z}_C = \frac{1}{-jX_C} = \boxed{\frac{j}{X_C} = \underbrace{\frac{1}{X_C}}_{B_C} \angle 90^\circ} \mho$$

Impedance and Admittance Diagrams (Find Z_T)



$$Z_T = \frac{1}{\frac{1}{Z_R} + \frac{1}{Z_L}}$$

$$Z_T = \frac{1}{\frac{1}{20} + \frac{1}{j10}}$$

Z_T = (4+j8) Ohms
Or
8.94 Ohms < 63.4 Deg

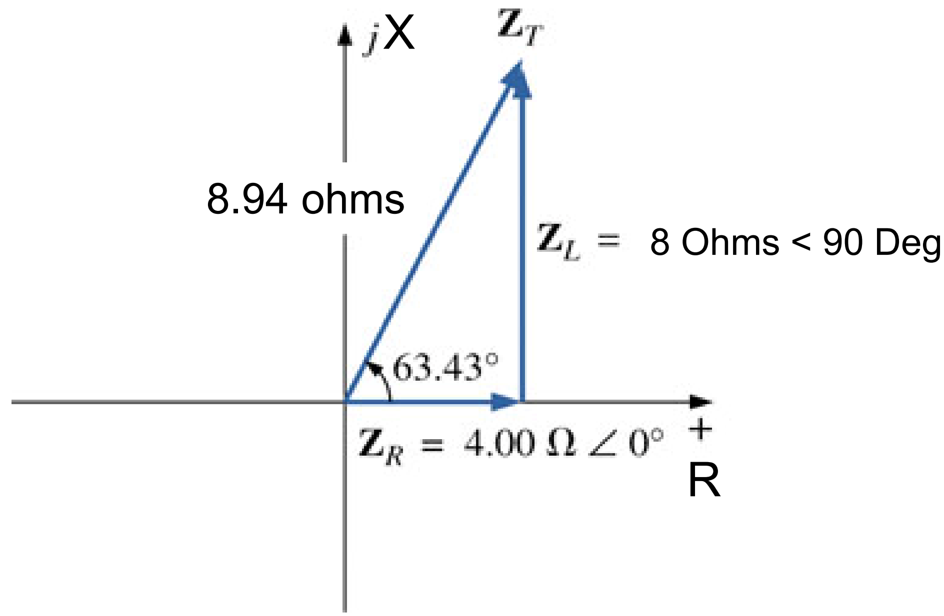
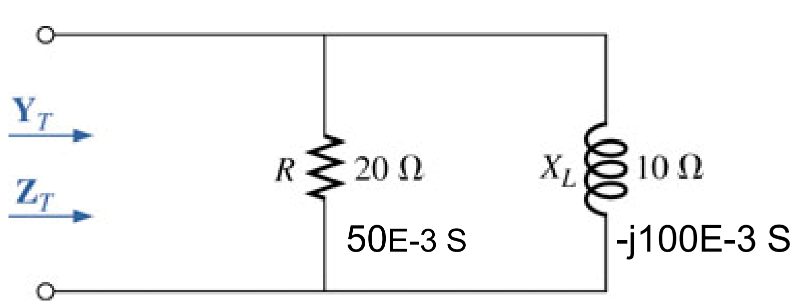


FIG. 16.4 *Impedance diagram for the network in Fig. 16.3.*

Impedance and Admittance Diagrams (Find Y_T)



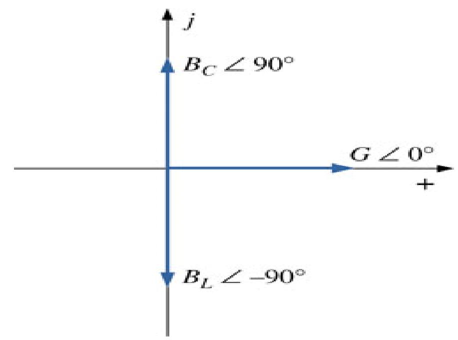


FIG. 16.8 *Admittance diagram.*

Z_T = (4+j8) Ohms
Or
8.94 Ohms < 63.4 Deg

$Y_T = 1/Z_T$
= (50E-3-j100E-3) S
Or
111.8E-3S < -63.4 Deg

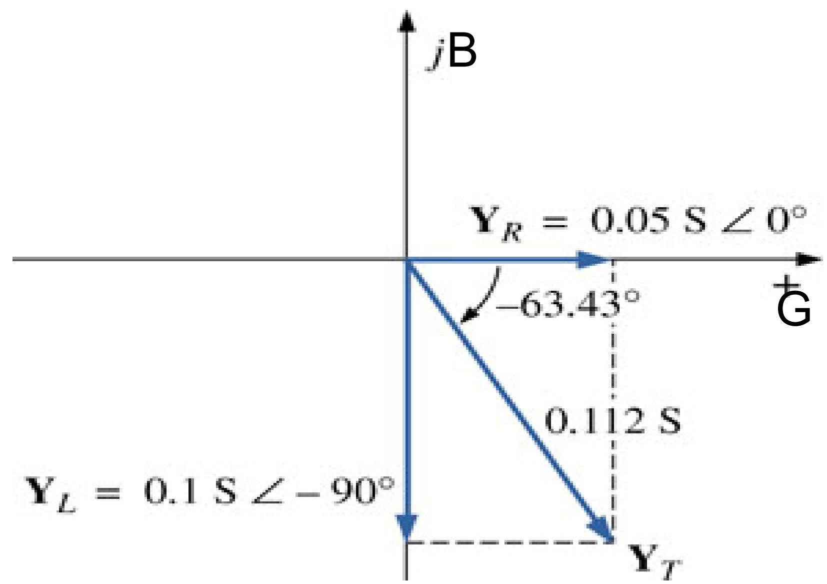
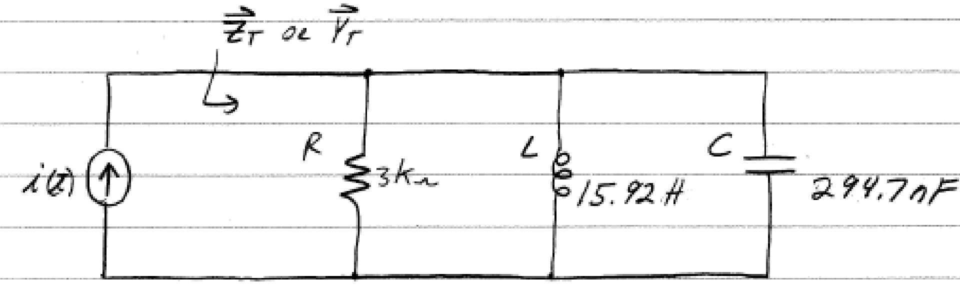


FIG. 16.9 *Admittance diagram for the network in Fig. 16.3.*

PARALLEL AC CIRCUIT EXAMPLE



$i(t) = 3\sin(377t + 60^\circ)$ mA

FIND: $\vec{Z}_T$, $\vec{Y}_T$

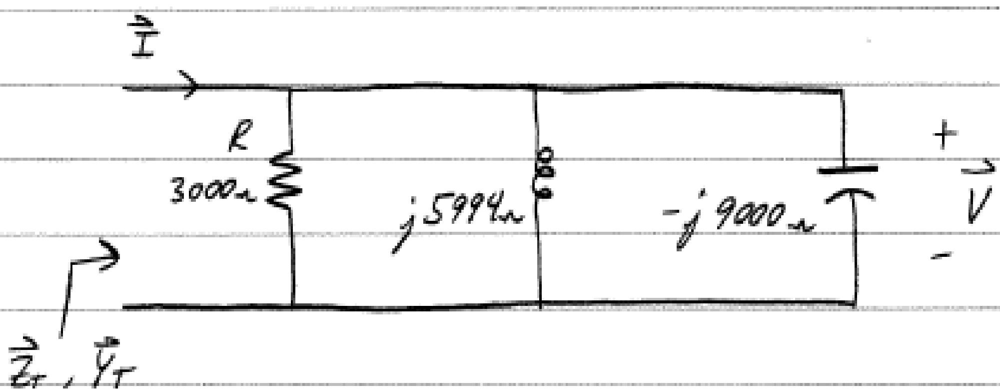
FIND: $\vec{Z}_T$, $\vec{Y}_T$

→ REDRAW

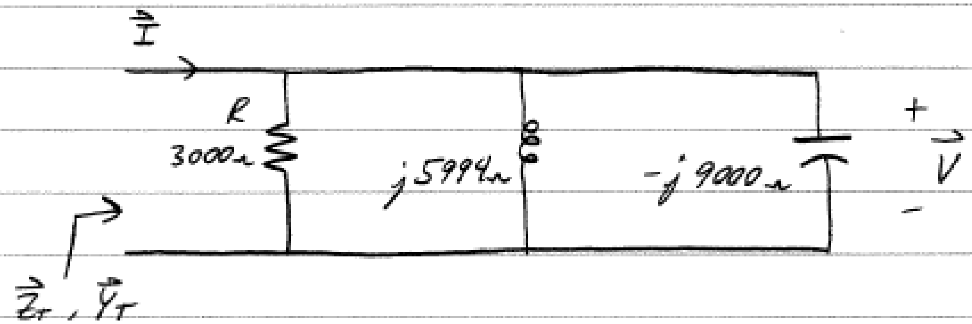
$\vec{Z}_L = j\omega L = j(377)(15.92) = j\,5{,}994\Omega$

$\vec{Z}_C = \dfrac{-j}{\omega C} = \dfrac{-j}{(377)(294.7nF)} = -j\,9k\Omega$

Slight rounding error (15.92H entered as 15.9H)



Parallel AC Circuit Analysis – Using ZT

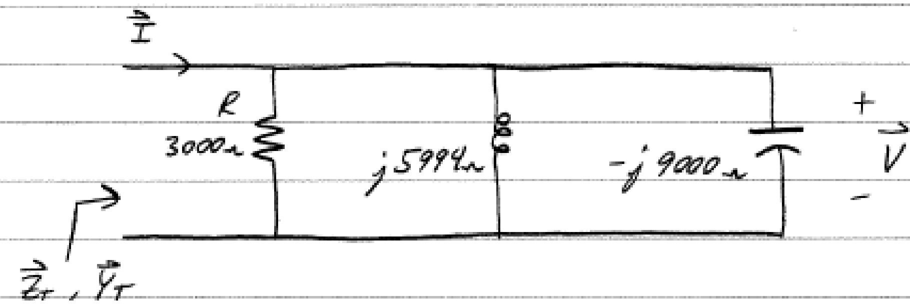


$Z_T,\ Y_T$

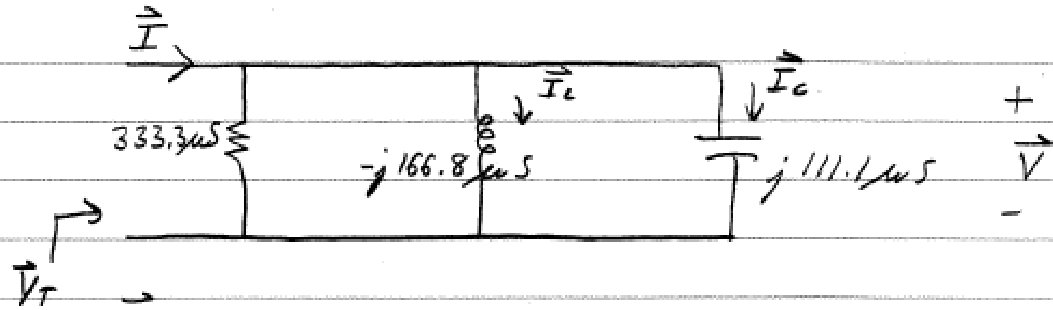
$$\vec{Z}_T = \frac{1}{\frac{1}{3000} + \frac{1}{j5994} + \frac{1}{-j9000}} = \boxed{2{,}918 + j487.9\ \Omega \quad \text{OR} \quad 2{,}959\ \Omega \angle 9.49^\circ}$$

$$\vec{Y}_T = 1/\vec{Z}_T = \boxed{333.3\times10^{-6} - j55.72\times10^{-6}\ S \quad \text{OR} \quad 338\,\mu S \angle -9.49^\circ}$$

Parallel AC Circuit Analysis – Using Y_T



ALTERNATE APPROACH



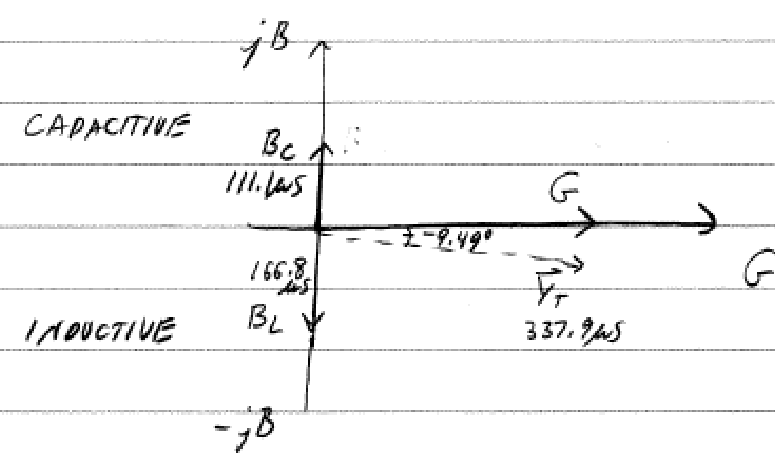
$$\vec{Y}_T = 333.3\,\mu S - j166.8\,\mu S + j111.1\,\mu S$$

$$\vec{Y}_T = \boxed{333.3\times10^{-6} - j55.7\times10^{-6}\ S}$$

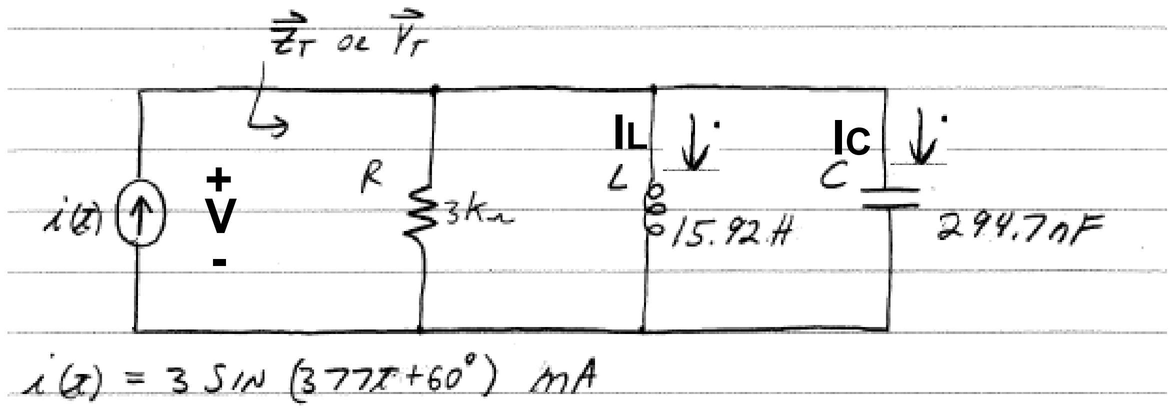
OR

$$\boxed{337.9\,\mu S \angle -9.49^\circ\ S}$$

ADMITTANCE DIAGRAM



ICP – Parallel AC Circuit Analysis



1 – Find the voltage **V** across the elements (use RMS)

2 – Find v(t), the voltage across the elements

3 - Find **I_L** and **I_C** (use RMS)

4 - Find $i_L(t)$ and $i_C(t)$