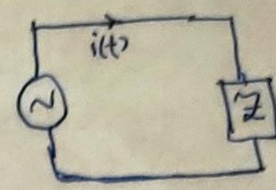
* The voltage source is connected to a load and draws current.

Let $\begin{cases} v(t) = \sqrt{2} \times 20 \times \cos(\omega t) \\ i(t) = \sqrt{2} \times 4 \times \cos(\omega t - 60^\circ) \\ \omega = 2\pi \times 60 \ \text{Rad/s} \end{cases}$



Calculate:

1) Phasor of voltage: $V = |V| \measuredangle \theta_v$ $\begin{cases} |V| = ? \\ \theta_v = ? \end{cases}$

2) Phasor of current: $I = |I| \measuredangle \theta_i$ $\begin{cases} |I| = ? \\ \theta_i = ? \end{cases}$

3) Active power:

4) Reactive power:

5) Apparent power:

6) Complex power:

7) power factor:

8) power factor angle:

9) Impedance Z: $Z = |Z| \measuredangle \theta_Z$ $\begin{cases} |Z| = ? \\ \theta_Z = ? \end{cases}$

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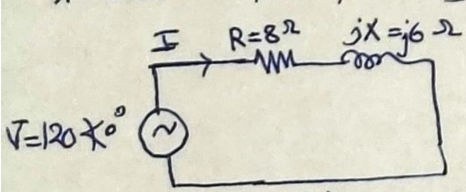
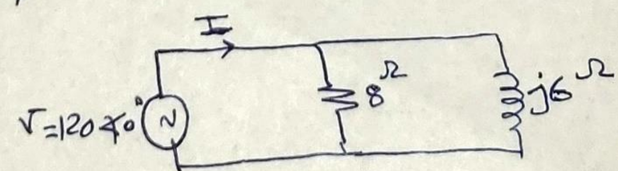
* Consider the following systems:



(a)



(b)

For each case, calculate:

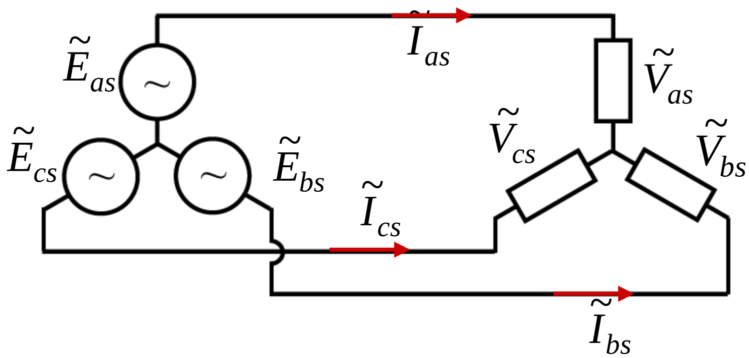
1) Phasor of current I.

2) Active power

3) Reactive power

4) Apparent power

Assume that we have the following circuit and the line is purely inductive with reactance *X*. Formulate the active and reactive power if the phasors of voltage on the left-side lead the phasors of the voltage on the right-side, by the angle δ .



B.4 Δ–Y TRANSFORMATION OF LOAD

Sometimes it might be Δnecessary to transform a Δ load to a Y load and vice versa. Consider the equivalent Δ load and Y load shown in Fig. B.8. For the Δ load,

$$\begin{aligned} I_a = I_{ab} - I_{ca} &= \frac{V_{ab} - V_{ca}}{Z_\Delta} \\ &= \frac{(V_a - V_b) - (V_c - V_a)}{Z_\Delta} \\ &= \frac{3V_a - (V_a + V_b + V_c)}{Z_\Delta} \\ &= \frac{V_a}{Z_\Delta/3} \end{aligned} \tag{B.59}$$

For the Y load,

$$I_a = \frac{V_a}{Z_Y} \tag{B.60}$$

From Eqs. B.59 and B.60,

$$Z_y = \frac{Z_\Delta}{3} \tag{B.61}$$

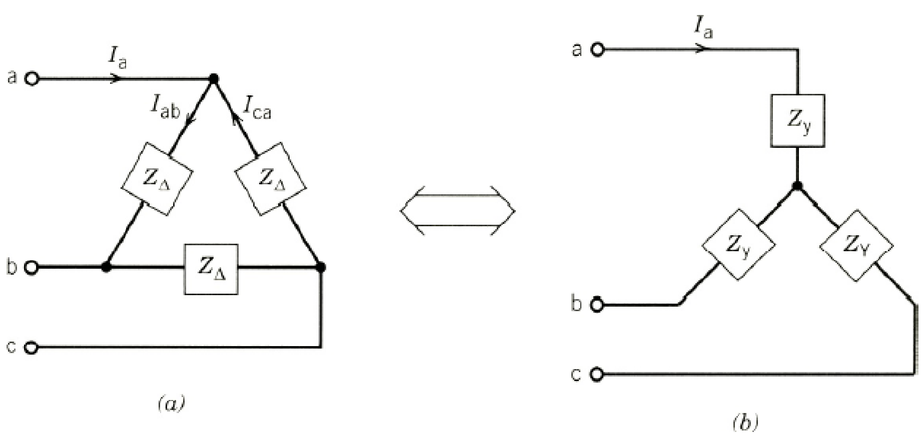


FIGURE B.8 Equivalent Δ load and Y load.

B.5 PER-PHASE EQUIVALENT CIRCUIT

Consider the three-phase balanced power system shown in Fig. B.9*a*, in which the source and the load are connected in delta, and they are connected through the transmission line impedances Z_l. This three-phase system can be analyzed by deriving a "per-phase" equivalent circuit as shown in Fig. B.9*b*, in which the source is represented by an equivalent Y voltage, V_a, and the load is represented by an equivalent Y load, Z_Y.

If the line voltage, V_{ab}, is the reference voltage, then

$$V_a = \frac{|V_{ab}|}{\sqrt{3}} \underline{/-30^\circ} \tag{B.62}$$

and

$$Z_Y = \frac{Z_\Delta}{3} \tag{B.63}$$

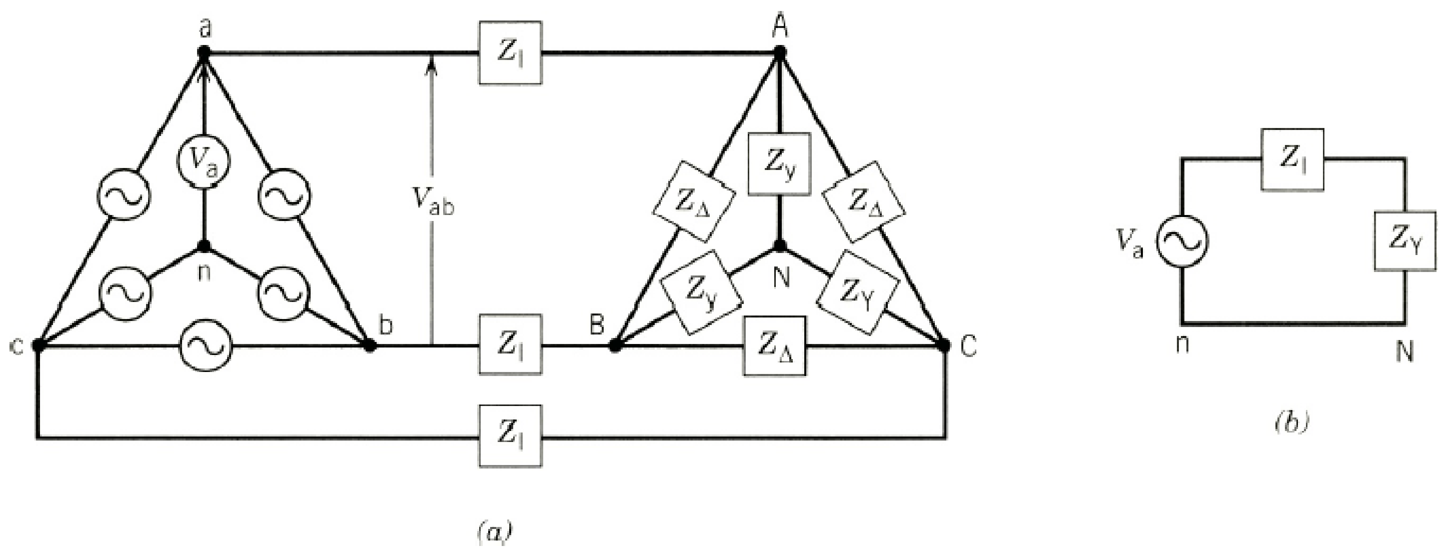
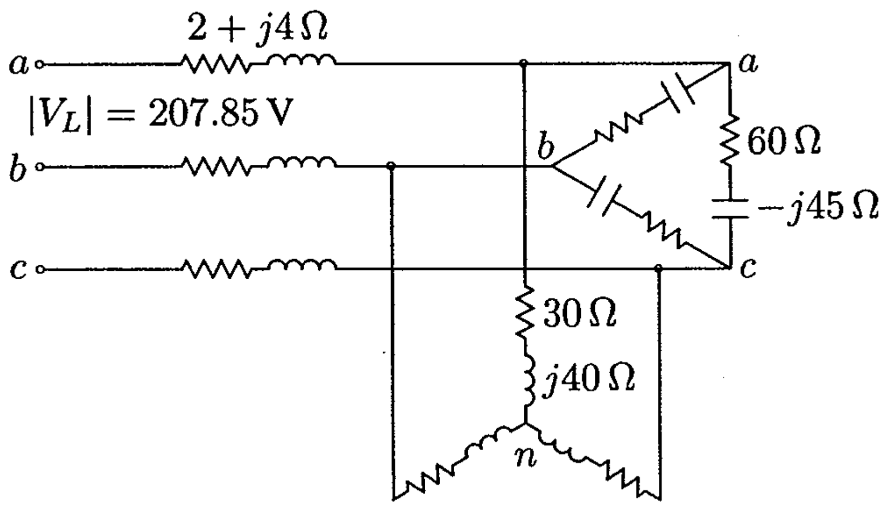


FIGURE B.9 Three-phase power system. (*a*) Circuit. (*b*) Per-phase equivalent circuit.

Problem:

A three-phase line has an impedance of $2 + j4\ \Omega$ as shown in Figure ·



The line feeds two balanced three-phase loads that are connected in parallel. The first load is Y-connected and has an impedance of $30+j40\ \Omega$ per phase. The second load is Δ-connected and has an impedance of $60 - j45\ \Omega$. The line is energized at the sending end from a three-phase balanced supply of line voltage 207.85 V. Taking the phase voltage V_a as reference, determine:

(a) The current, real power, and reactive power drawn from the supply.
(b) The line voltage at the combined loads.
(c) The current per phase in each load.
(d) The total real and reactive powers in each load and the line.