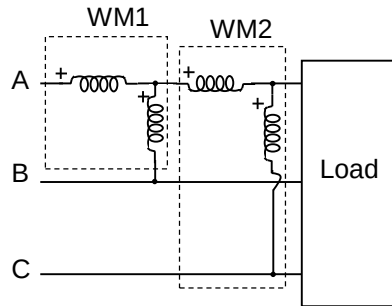


HOMEWORK VI

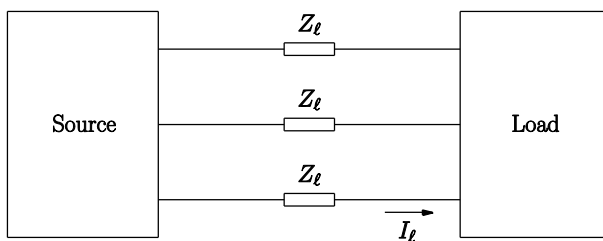
In the following balanced three-phase circuits, the phase sequence is positive.

Question 1) In a balanced three-phase circuit, the wattmeters WM₁ and WM₂ are connected to the load as shown in the figure below. The wattmeter readings are 500 W and 1000 W, respectively. Determine the complex power input to the load.



Answer $1500 + j500\sqrt{3}$ VA.

Question 2) Consider the following balanced three-phase circuit with Δ -connected inductive load.



$$P_{Load} = 14.4 \text{ kW},$$

$$Z_\ell = 1/3 + j4/9 \Omega,$$

$$\text{The percent efficiency, } \eta = 90 \%,$$

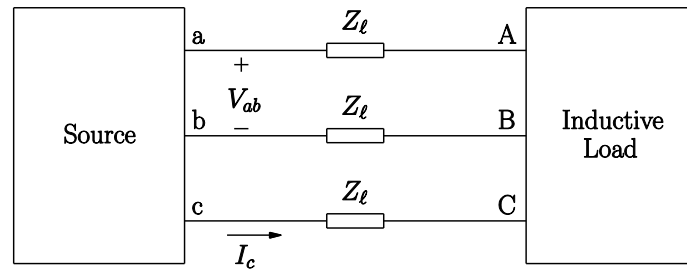
The effective value of the line-to-line voltage at the source side is $2\sqrt{3}/9$ kV.

Find,

- The effective value of the line current, I_ℓ ,
- The complex power supplied by the source,
- The effective value of the line-to-line voltage at the load side,
- The per-phase impedance of the load.

Answer a) 40 A, b) $16 + j(64/3)$ kVA, c) $200\sqrt{3}$ V, d) $9 + j12 \Omega$.

Question 3) Consider the following balanced 3-phase circuit.



Given,

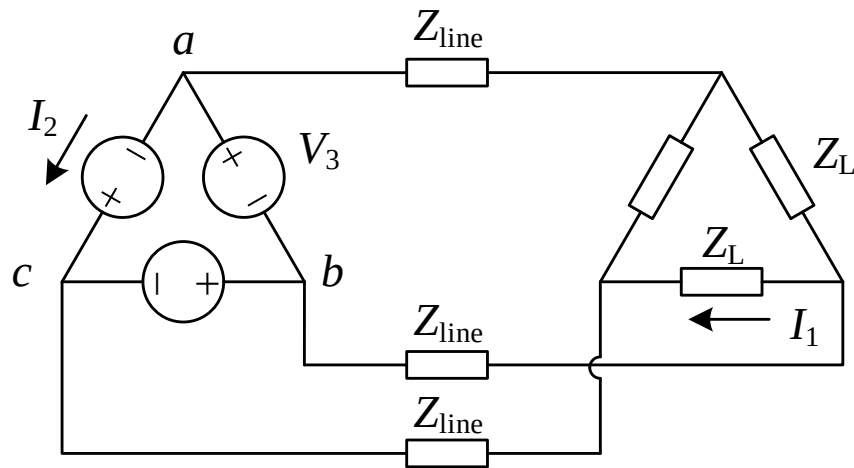
- The real power of the load: $P_L = 90 \text{ kW}$,
- The apparent power of the load: $S_{Lm} = 30\sqrt{10} \text{ kVA}$,
- The reactive power absorbed by the line: $Q_\ell = 18 \text{ kvar}$,
- The apparent power of the source: $S_{Sm} = 48\sqrt{5} \text{ kVA}$,
- The line voltage at the source side: $v_{ab}(t) = 160\sqrt{30} \cos(100\pi t + 80^\circ) \text{ V}$.

Find,

- The complex power S_S supplied by the source,
- The line current I_c ,
- The line impedance Z_ℓ ,
- The line voltage at the load side $v_{AC}(t)$.

Answer a) $96 + j48 \text{ kVA}$, b) $100e^{j143.43^\circ} \text{ A}_{rms}$, c) $0.2 + j0.6 \Omega$,
d) $200\sqrt{15} \cos(100\pi t + 11.87^\circ) \text{ V}$.

Question 4) Consider the following balanced 3-phase circuit.



Given,

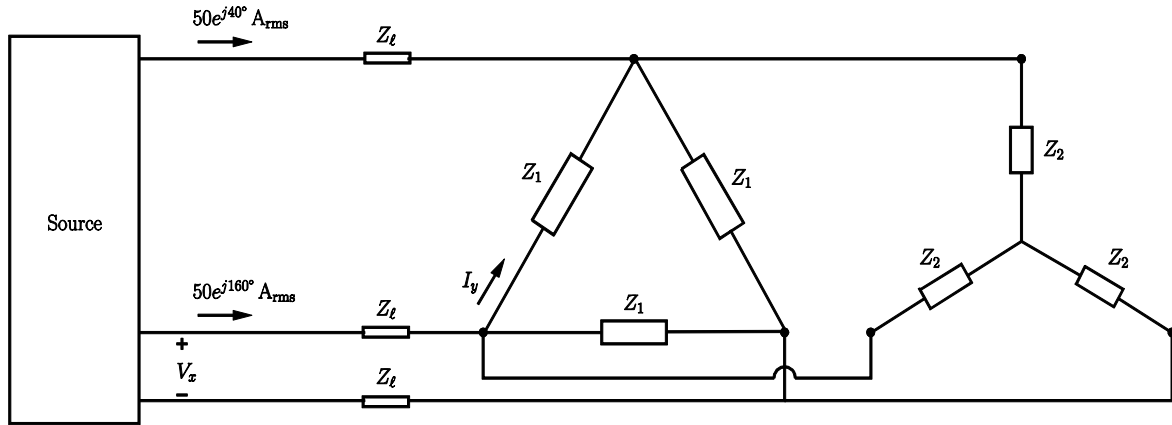
$$Z_L = 6 + j3 \Omega, I_1 = 20e^{j15^\circ} \text{ A}_{rms},$$

The complex power supplied by the source: $10.8\sqrt{2}e^{j45^\circ} \text{ kVA}$.

Find Z_{line} , I_2 , V_3 .

Answer $Z_{line} = 1 + j2 \Omega$, $I_2 = 20e^{-j105^\circ} \text{ A}_{rms}$, $V_3 = -180\sqrt{2} \text{ V}_{rms}$.

Question 5) Consider the following balanced 3-phase circuit.



Given,

The frequency of operation: $f = 50$ Hz,

$Z_l = (2 + j14)/15 \Omega$, $Z_1 = 24 + j12 \Omega$,

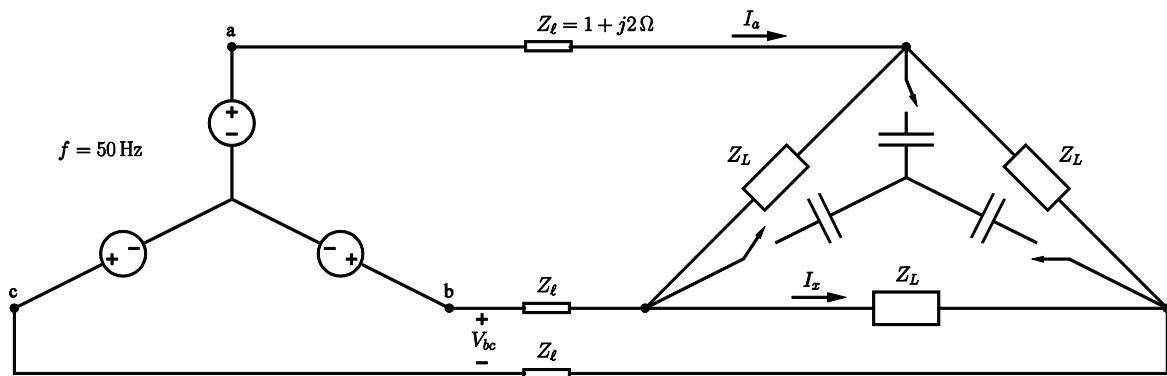
The complex power supplied by the source: $S_S = 25 + j25$ kVA.

Find $v_x(t)$, $i_y(t)$, Z_2 .

Answer $v_x(t) = (1000/\sqrt{3}) \cos(100\pi t + 175^\circ) \text{ V}$,

$i_y(t) = -(10\sqrt{30}/3) \cos(100\pi t + 20.3^\circ) \text{ A}$, $Z_2 = 5 + j5 \Omega$.

Question 6) Consider the following balanced 3-phase circuit. The load is inductive.



a) The capacitor bank is not connected. (The switches are open).

Given,

The percent efficiency: $\eta = 90 \%$; $I_a = 20e^{j10^\circ} \text{ A}_{rms}$,

The apparent power of the source: $S_{Sm} = 6\sqrt{5} \text{ kVA}$.

Find the complex power supplied by the source (S_S), Z_L ; I_x ; $v_{bc}(t)$.

b) The (balanced) capacitor bank is connected to the circuit. (The switches are closed). The source voltage magnitudes are so adjusted that the effective value of the line voltage at the load side is as in Part (a). The per-phase capacitance C is such that the efficiency is maximum. Find C and the percent efficiency η .

Answer a) $S_s = 12 + j6 \text{ kVA}$, $Z_L = 27 + j9 \Omega$, $I_x = (20/\sqrt{3})e^{-j80^\circ} \text{ A}_{rms}$,
 $v_{bc}(t) = 100\sqrt{30} \cos(100\pi t - 53.43^\circ) \text{ V}$.
b) $C \cong 106.1 \mu\text{F}$, $\eta = 90.91 \%$.