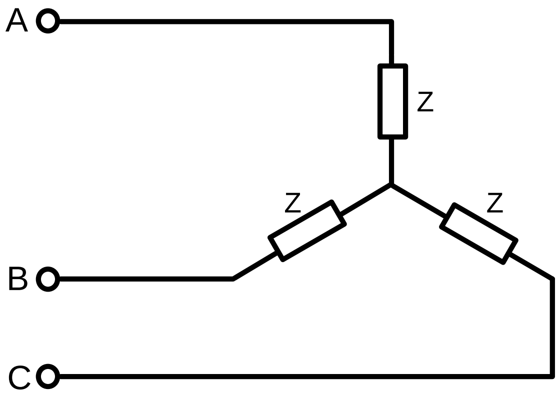
Tutorial Sheet -4 (Three phase)

Basic Electrical Engineering

Q 1: Calculate all line current phassors if the supply voltage is 173.2 V and impedance Z = $100\angle 30°$ Ω. The phase sequence is ABC. Consider phase A voltage as reference.

$$[\dot{I}_A = 1\angle -30° A, \dot{I}_B = 1\angle -150° A, and\ \dot{I}_C = 1\angle -270° A]$$



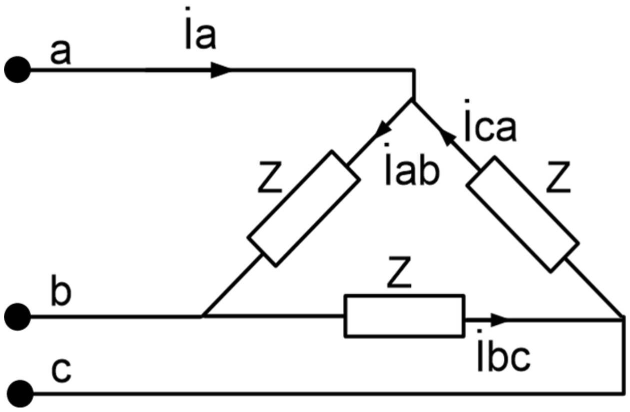
Q 2: A balanced star connected load, with Z = $65\angle -20°$, is connected to a three-phase, three-wire, CBA system where $\dot{V}_{AB} = 678.8\angle -120°$. Find the three line currents.

$$[\dot{I}_A = 6.03\angle -70°\ A, \dot{I}_B = 6.03\angle 50°\ A, and\ \dot{I}_C = 6.03\angle 170°\ A]$$

Q 3: A balanced delta connected load having an impedance of 15+j25 Ω is connected to a 3-phase generator with $\dot{V}_{ab}$=200 ∠0° V. Calculate load side phase and line currents. The phase sequence is abc.

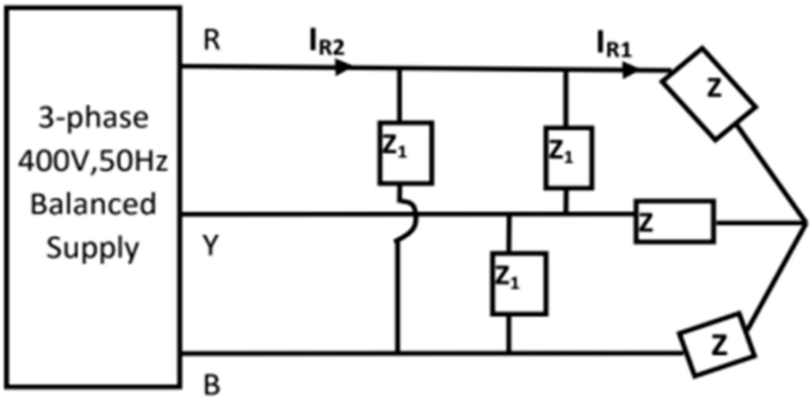
$\dot{I}_{ab} = 6.86\angle -59.04° A, \dot{I}_{bc} = 6.86\angle -179.04° A,$ $\dot{I}_{ca} = 6.86\angle 60.96° A$

$\dot{I}_a = 11.88\angle -89.04° A, \dot{I}_b = 11.88\angle 150.96° A,$ $\dot{I}_c = 11.88\angle 30.96° A$



Q 4 : For the 3-phase balanced system shown, calculate the current phasors I_{R1} and I_{R2} as marked with R-phase supply voltage as reference (sequence be RYB). Each $Z=10\angle 30^{\circ}\ \Omega$ and each $Z_1=30\angle -90^{\circ}\ \Omega$.

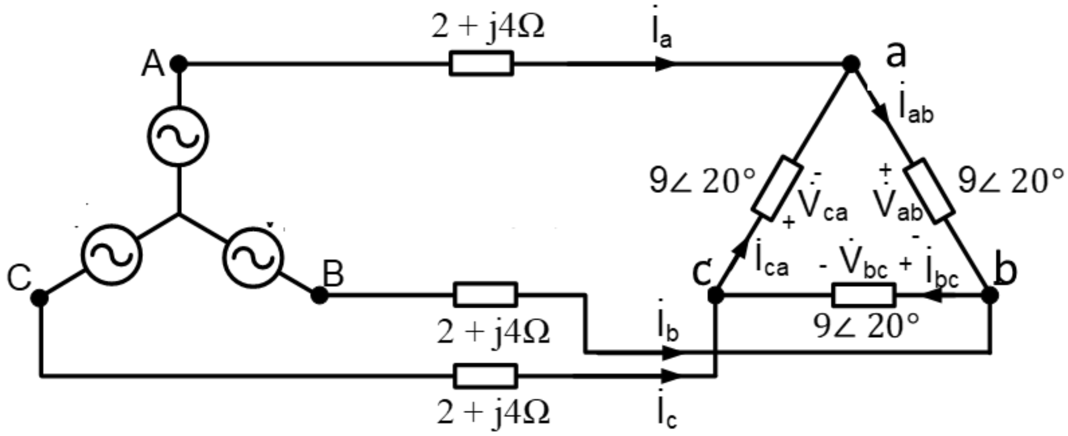
$$[I_{R1} = 23.094\angle -30°A \ and\ I_{R2} = 23.094\angle 30°A]$$



Q 5 :

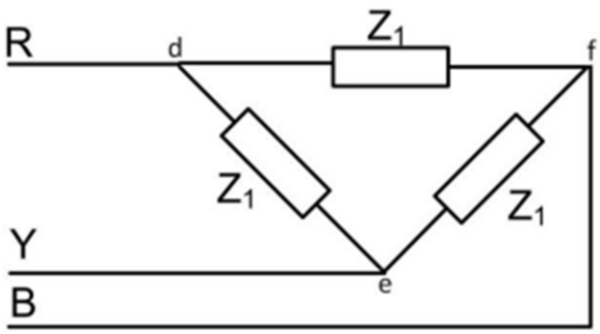
For the circuit, considering $\dot{V}_A = 120\angle 0°\ V,$ compute each line voltage at the load side, line current, and phase currents in the loads (both magnitude and angles). The phase sequence is abc.

$\dot{I}_{ab} = 9.95\angle -16.2°A,$ $\dot{I}_{bc} = 9.95\angle -136.35°A,$ $\dot{I}_{ca} = 9.95\angle 103.8°A$	$\dot{I}_a = 17.23\angle -46.2°A,$ $\dot{I}_b = 17.23\angle -166.2°A,$ $\dot{I}_c = 17.23\angle 73.8°A$	$\dot{V}_{ab} = 89.55\angle 3.8°A,$ $\dot{V}_{bc} = 89.55\angle -116.2°A,$ $\dot{V}_{ca} = 89.55\angle 123.8°A$



Q 6: (a) $Z_1 = 8 + j5\Omega$, phase sequence is RYB and the source voltage is 400V, 50 Hz. Calculate reactive power (Q) drawn from the source and the power factor (pf) seen from the source side. (b) Considering $\dot{V}_R$ as the reference voltage, find $\dot{I}_R$. (c) Find the value of capacitor C connected in delta at terminals def such that the power factor seen by the source is unity.

$$Q = 26975var, \quad pf = 0.84(lagging), \quad \dot{I}_R = 73.43\angle -32°A, and\ C = 178.9\ \mu F$$

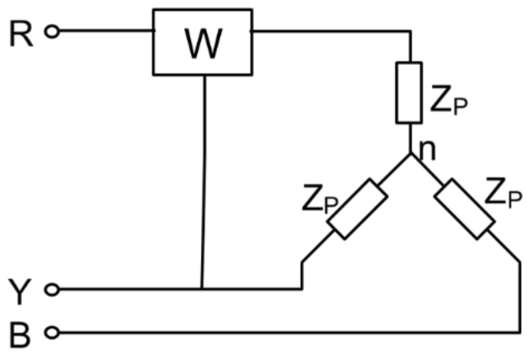


Q 7: A 400 V, 3-phase supply is connected to a 3-phase balance load, which draws 30A at a pf of 0.9 lagging. Phase sequence is RYB. A wattmeter is connected as shown.

(i) What will be the reading (W_1) of the wattmeter?

(ii) If the load is changed to 30A with 0.9 leading, what will be the reading (W_2) of the wattmeter?

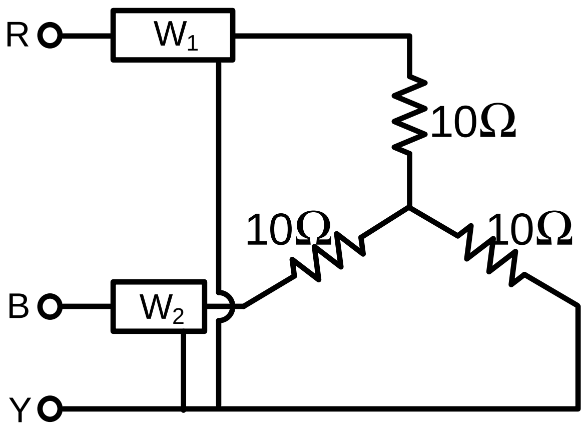
$[W_1 = 6738.07W \; and \; W_2 = 11968.38 \; W]$



Q 8:

Three nonreactive resistances are connected across a symmetrical 3-phase 400 V system in the circuit. Determine current in each line, the total power (P_T) input to circuit and the reading on each of the wattmeter (W_1 and W_2). The phase sequence is RYB.

$$\dot{I}_R = 23.1\angle 0° \; A, \dot{I}_Y = \; 23.1\angle -120° A, \dot{I}_B = 23.1\angle -240° \; A, W_1 = 8000W, W_2 = 8000W, and \; P_T = 16000W$$



<u>Q 9</u>: A 3-phase, 3-wire, 100 V system supplies a balanced Δ-connected load with each impedance of $20\angle 45°\ \Omega$. (i) Determine the phase and line currents. (ii) Find the wattmeter readings (W_1 and W_2). The phase sequence is ABC and phasor V_{AB} is the reference.

$\dot{I}_{AB} = 5\angle -45°A, \dot{I}_{BC} = 5\angle -165°A, \dot{I}_{CA} = 5\angle 75°A\ \dot{I}_A = 8.66\angle -75°A, \dot{I}_B = 8.66\angle -195°A, \quad \dot{I}_C = 8.66\angle 45°A$

$W_1 = 836.5W$ and $W_2 = 224.14W$

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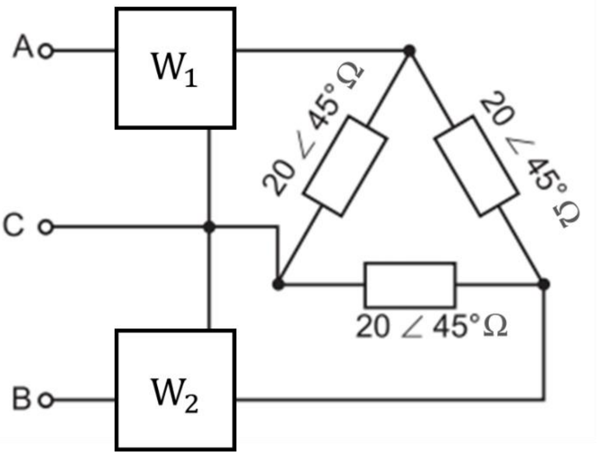

Q10: Two balanced loads are connected to a 11 kV , 50-Hz line, as shown. Load 1 draws 100 kW at a power factor of 0.8 lagging, while load 2 draws 45 kvar at a power factor of 0.9 lagging. Assuming the abc sequence, determine: (a) the real (P), and reactive powers (Q) absorbed by the combined load, (b) the line current (I_L) flowing from the supply, and (c) the rating of the star connected capacitor (C) in parallel with the load that will raise the combined power factor to 0.9 lagging and the capacitance of each capacitor.

$$[P = 192.9kW, Q = 120kvar, I_L = 11.92A, C = 0.7\mu F\ ]$$