Tutorial Sheet-3 (Three Phase Networks)

1. A high-voltage generator is connected to a 3-phase wye connected load through a transmission line. Each phase of the line has impedance *Zl*, and the load is a balanced wye with branch impedance *Z*. Line to line voltage, |*Vab*| = 45kV, *Zl* = (0.5 + *j*3) Ω, *Z* = (4.5 + *j*9) Ω. Find the line currents, power consumed by the load and line losses. Draw the phasor diagram.

   [Ans. $I_a = 2\angle -67.38°$ A, $I_b = 2\angle 172.62°$ A, $I_c = 2\angle 52.62°$ A, P_{load} = 53.99 MW, P_{line} = 6 MW]

2. A balanced 3-phase a-b-c system with line-to-line voltage $Vab = 208\angle 0^0$ V supplies to a balanced Δ connected load of 3 kW with a power factor of 0.8 (lag) through ideal conductors. Find the line currents. Draw the phasor diagram.

   [Ans. $I_a = 10.41\angle -66.9°$ A, $I_b = 10.41\angle 173.1°$ A, $I_c = 10.41\angle 53.1°$ A]

3. A balanced 3-phase delta connected load of 160 kW, connected to a balanced line voltage of 1100 V, 50 Hz, takes a leading current of 100 A. Find the circuit elements of the load per phase.

   [Ans. R_{ph} = 16 Ω, C_{ph} = 307.87 μF]

4. Calculate the value of X_C in Fig. 1 such that the combined circuit behaves as a three-phase balanced resistive network. [Ans. 37.5 Ω]

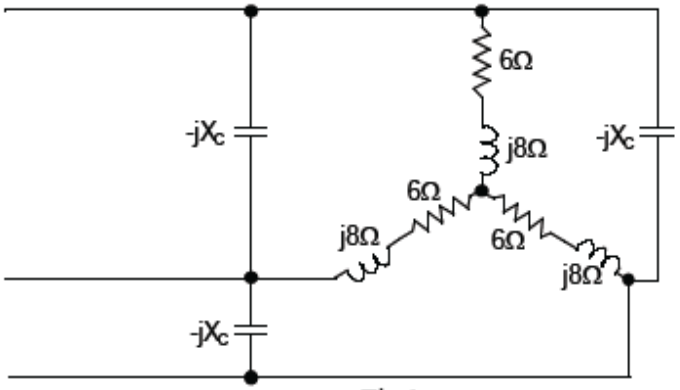

Fig.1

5. For the 3-phase balanced system of Fig.2 calculate the current phasors I_{R1} and I_{R2} as marked in the figure with R-phase supply voltage as reference (sequence be RYB). Each Z=$10\angle 30^0$ Ω and each Z1=$30\angle -90^0$ Ω.

[Ans. I_{R1}= 23.094∠ − 30° A, I_{R2} = 23.094∠30° A]

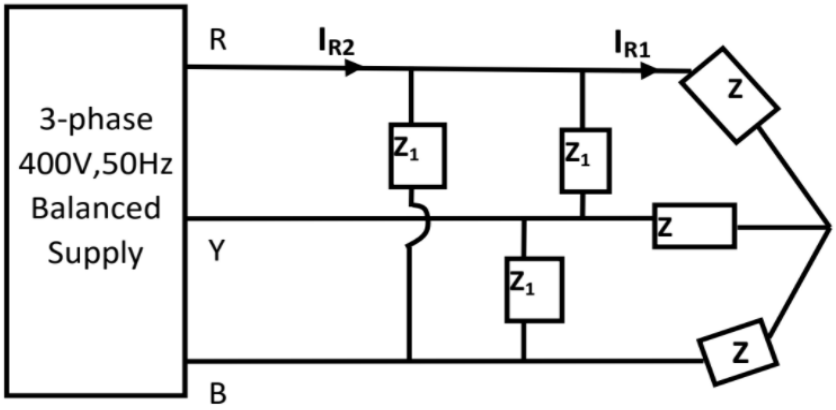

Fig. 2.

6. For the circuit shown in Fig. 3, calculate the branch currents of the Δ connected load and the active and reactive power consumed by it.

[Ans. I_{RB} = 5.75∠ − 30° A, I_{BY} = 5.78∠90° A, I_{RY} = 5.78∠ 30° A, P = 499 W, Q = 499 VAR]

Fig. 3.

7. In the circuit of Fig. 4, A three phase balanced voltage source is supplying power to a three-phase load as shown in Fig. 3. Calculate the line currents.

[Ans. I_a = 41.55∠ − 44.86° A, I_b = 41.55∠ − 164.86° A, I_c = 41.55∠75.14° A]

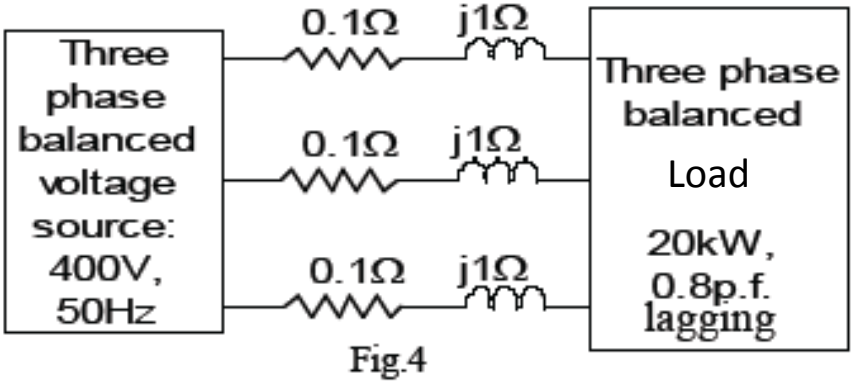

Fig.4

8. A wattmeter reads 5.54 kW when its current coil is connected in R phase and its voltage coil connected between the neutral and the R phase of a symmetrical 3-phase system supplying a balanced load of 30 A at 400 V. What will be the reading on the instrument if the connections to the current coil remain unchanged and the voltage coil be connected between B and Y phases? Take phase sequence RYB. Draw the corresponding phasor diagram. [Ans. 7.2 kW]

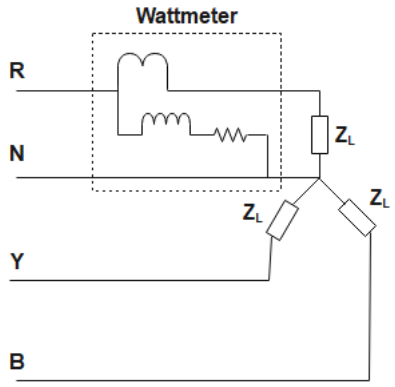

Fig. (a)

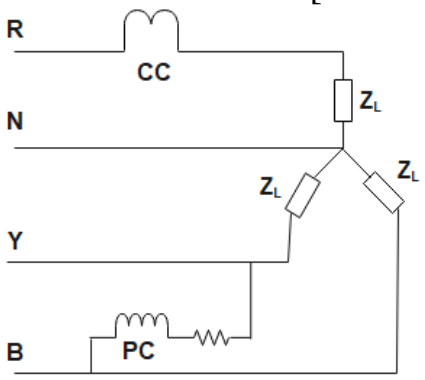

Fig. (b)

9. Calculate the readings of the two wattmeters (W1 and W2) connected to measure the total power for a balanced delta-connected load fed from a three-phase, 400 V balanced supply with phase sequence as R-Y-B as shown in Fig.5. The load impedance per phase contains capacitive reactance, Xc=14 Ω and resistance, R=14 Ω. [Ans. W1 = 13.52 kW, W2 = 3.623 kW]

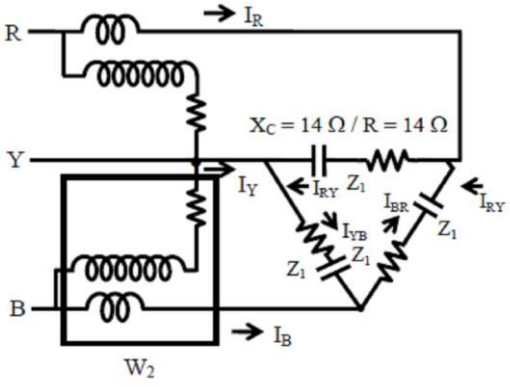

Fig. 5

10. Figure 6 shows a balanced 3-phase, 3 wire system with positive phase sequence. Let $\bar{V}_{BC} = 120\angle 60^0$ V and $R_W = 0.6\ \Omega$. If the total load (including wire resistance) draws 5 kVA at p.f.= 0.8 lag, find (a) the total power loss in the wire resistance, (b) $\bar{V}_{an}$.

[Ans: 823.56 W, $78.96\angle 143.47^0$]

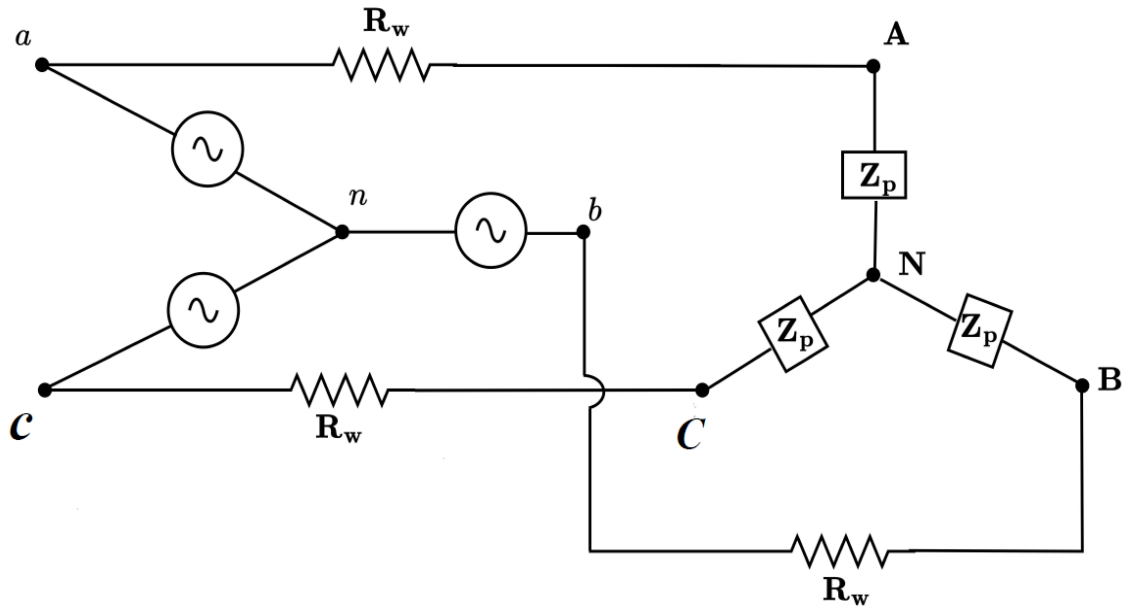

Fig. 6