Tutoria1 8

Unbalanced star connected load and measurement of three phase power

1. A star load with $Z_A = (2 - j1)\ \Omega$, $Z_B = (2 + j3)\ \Omega$ and $Z_C = (3 + j0)\ \Omega$ is connected to a 3-phase, 4-wire, 100 volts, ABC system. Find the line currents including the neutral assuming the positive direction is towards the load. Take V_{AB} as the reference voltage.
   Ans: $I_A = 25.77\angle -3.44^o$ A, $I_B = 16.04\angle 153.7^o$ A, $I_C = 19.24\angle 90^o$ A,
   $I_N = -27.3\angle 65.42^o$ A $= 27.3\angle -114.58^o$ A

2. A 3-phase, 4-wire, 440 V system is loaded as follows:
   Resistance loads of 150 kW, 250 kW and 400 kW connected between neutral and the A,B and C lines respectively. Calculate the:
   (a) line currents,
   (b) neutral current (flowing towards the supply) and
   (c) total power of the system.
   Phase sequence, ABC. Take V_{AN} as reference.
   Ans: $I_A = 590.48\angle 0^o$ A, $I_B = 984.14\angle -120^o$ A, $I_C = 1574.62\angle -240^o$ A
   $I_N = 857.95\angle 143.41^o$ A, Total power = 800 kW

3. Three equal resistances of 20 Ω each are connected in delta, and a star load with phase impedances $Z_A = (3 + j4)\ \Omega$, $Z_B = (6 - j8)\ \Omega$ and $Z_C = (9 + j12)\ \Omega$ are connected to a three phase, 4-wire, 440 V, ABC system. Taking the phase voltage V_{BN} as the reference, calculate the:
   (a) line currents and three phase power for the balanced delta connected resistive load.
   (b) line currents and each phase power for the star connected unbalanced load.
   (c) total power for the combined loads.
   (d) neutral current I_N flowing towards the loads.
   Ans: (a) Delta load: $I_B = 38.1\angle 0^o$ A, $I_C = 38.1\angle -120^o$ A, $I_A = 38.1\angle -240^o$ A,
   P = 29.04 kW
   (b) Star load: $I_B = 25.40\angle 53.13^o$ A, $I_C = 16.93\angle -173.13^o$ A, $I_A = 50.8\angle -293.13^o$ A,
   $P_B = 3.871$ kW, $P_C = 2.58$ kW, $P_A = 7.74$ kW
   (c) $P_T = 43.23$ kW
   (d) $I_N = 67.56\angle -105.79^o$ A (flowing towards the load)

4. The power input to a 2 kV, 50 Hz 3-phase motor running on full load at an efficiency of 90 per cent is measured by the two wattmeters which indicate as 300 kW and 100 kW. Calculate the:
   (a) input power,
   (b) output power and
   (c) line current if the power factor is 0.756 lagging.
   Ans: $P_{in} = 400$ kW, $P_{out} = 360$ kW, $I_L = 152.74$ A

5. A balanced star-connected load, with each phase having a resistance of 10 Ω in series with an inductive reactance of 30 Ω is connected to a 400 V 50 Hz supply. The phase rotation is ABC. Using two-wattmeter method the two wattmeters are connected to read the total power with their respective current coils connected in the A and C lines respectively. Calculate the reading of each wattmeter.
Ans: W_1 or W_2 = 2184.59 W, W_2 or W_1 = –585.65 W

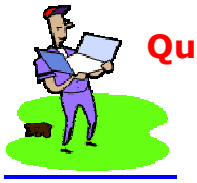
6. For a 3-phase 3-wire ABC system, determine the apparent power, reactive power, and true power for a Y-connected load consisting of $Z_A = Z_B = Z_C = 47\angle 45^0$. The line voltage is 122 V. If two wattmeter method were used for power measurement, with the current coils of the two wattmeters connected to the A and C lines respectively, determine the power indicated by each wattmeter.
Ans: S = 316.54 VA, Q = 223.8 VAR, P = 223.8 W, W_1 or W_2 = 47.3 W, W_2 or W_1 = 176.53 W

7. (a) Draw a labelled circuit diagram showing the connections of the wattmeter voltage and current coils in the two-wattmeter method, with the current coils of the two wattmeters connected in the A and B lines for measuring the total power consumption in a balanced three phase

(i) star-connected load and
(ii) delta-connected load.

(b) A balanced delta-connected load of impedance (15 + j10) Ω per phase is connected to a 400 V, 50 Hz, three-phase supply. The phase sequence is ABC. The total power consumption of the load is measured by the two-wattmeter method, with the current coils of the two wattmeters connected in the A and B lines. Calculate the reading of each wattmeter.

Ans: I_L = 38.43 A, W_1 or W_2 = 15.34 kW, W_2 or W_1 = 6.81 kW



Quiz – 2 questions (Unbalanced Star Load)
– 2 questions