EE2029 Introduction to Electrical Energy Systems

(Tutorial 3 - Three-Phase Circuit Analysis)

1. In a three-phase, three-wire circuit, find the phasor line currents to a balanced Y load for which Z_Y=60 $\angle$-30^0 Ω and V_{cb}=480 $\angle$65^0 V. The phase sequence is abc.

   (Answer: I_a=4.62 $\angle$5^0 A, I_b=4.62 $\angle$-115^0 A, and I_c=4.62 $\angle$125^0 A)

2. Calculate the total average power delivered by a three-phase source with the line to line voltage of 500 V to each of the following balanced Y connected loads with Z_L equal to:

   a) (30+j0) Ω;

   b) (30+j72) Ω;

   c) (30-j12.5) Ω.

   (Answer: (a) 8333.33 W, (b) 1232.75 W, (c) 7100.58 W)

3. Find the rms line voltage ($V_{Line-Line}$) at the source of the circuit in Fig. 1. As shown, rms phase voltage is 100V and each line impedance is 2+j3 Ω.

   (Answer: 173 V)

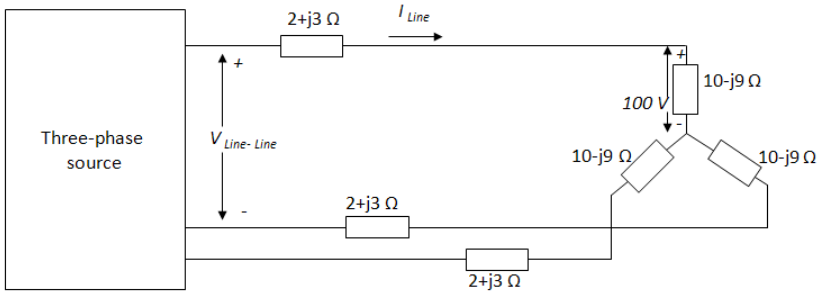

Fig. 1

4. A 208-V three-phase circuit has two balanced loads, one a Δ-connected load of 21 $\angle$30^0 Ω impedances and the other a Y-connected load of 9 $\angle$-60^0 Ω impedances. Find the total rms line current and also the total average power absorbed by the two loads.

   (Answer: 21.7 A, 7744.15 W)

5. In a 208-V three-phase circuit a balanced Δ load absorbs 2 kW at a 0.8 leading power factor. Find Z_Δ.

   (Answer: 51.9 $\angle$-36.87^0 Ω)

6. Two balanced three-phase motor loads comprising of an induction motor and a synchronous motor are connected in parallel. An induction motor draws 400 kW at 0.8 power factor lagging and a synchronous motor draws 150 kVA at 0.9 power factor leading. Both motor loads are supplied by a balanced three-phase 4160 V source. If the cable impedance between the source and load is neglected,
   a) Draw the power triangle for each motor and for the combined-motor load.
   b) Determine the power factor of the combined-motor load.
   c) Determine the magnitude of the line current delivered by the source.
   d) A delta connected capacitor bank is now installed in parallel with the combined-motor load. What value of capacitive reactance is required in each phase of the capacitor bank to make the source power factor unity?
   e) Determine the magnitude of the line current delivered by the source with the capacitor bank installed.

(Answer: (b) 0.916 lagging, (c) 81.1 A, (d) -j221.3 Ω, (e) 74.3 A)