Indian Institute of Technology Bombay
Department of Electrical Engineering

EE-114 : Power Engineering-1
Assignment: Three Phase Circuits

Instructions: Unless otherwise specified, take the voltage to be line-to-line rms.

1. Assume that the two balanced loads are supplied by an 840-V 60-Hz line. Load 1 is Y-connected with $30 + j40\ \Omega$ per phase, while load 2 is a balanced three-phase motor drawing 48 kW at a power factor of 0.8 lagging. Assuming the abc sequence, calculate:

   (a) the three phase complex power absorbed by the combined load,

   (b) the kVAR rating of each of the three capacitors delta-connected in parallel with the combined load to raise the power factor to unity, and

   (c) the current drawn from the supply at unity power factor condition.

   [(a) $56.47 + j47.29$ kVA, (b) 15.7 kVAR, (c) 38.813 A]

2. Each phase of a balanced three-phase delta connected load consists of a 200 mH inductor in series with the parallel combination of a 5 μF capacitor and a 200 Ω resistance. Assume zero line resistance and a phase voltage of 200 V at $\omega = 400$ rad/s. Find

   (a) the phase current,

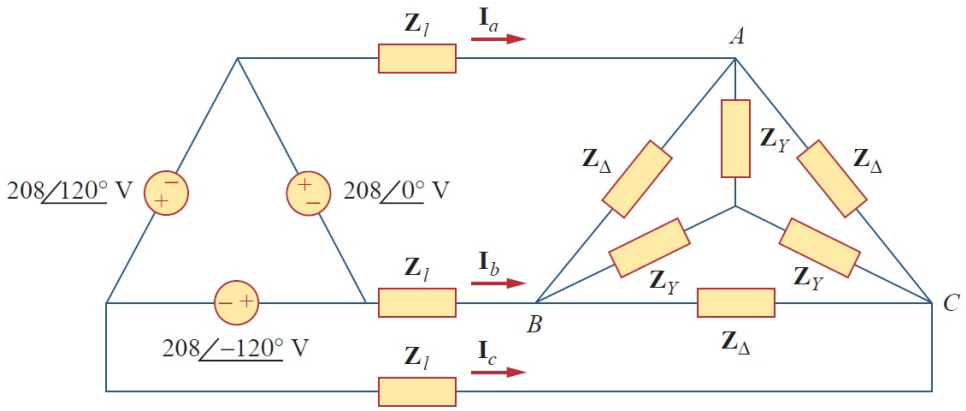
   (b) the line current, and

   (c) the total power absorbed by the load.

   [(a) 1.158 A, (b) 2.01 A, (c) 693 W]

3. A balanced delta connected source supplies a composite (star-delta) load through a transmission line as shown in the figure below. The line has a resistance, Z_l of 2 Ω per phase, $Z_\triangle$ is $12 - j15\ \Omega$ per phase, and Z_Y is $4 + j6\ \Omega$ per phase. Find the line currents I_a, I_b, and I_c.

   [$15.53\angle -28.4°$ A, $15.53\angle -148.4°$ A and $15.53\angle 91.6°$ A]



4. A balanced three-phase three-wire system has a line voltage of 500 V. Two balanced Y-connected loads are present. One is a capacitive load with $7 - j2\ \Omega$ per phase, and the other is an inductive load with $4 + j2\ \Omega$ per phase. Find

   (a) the phase voltage,

   (b) the line current,

   (c) total power drawn by the load, and

   (d) the power factor at which source is operating.

   [(a) 289 V, (b) 97.5 A, (c) 83 kW (d) 0.983 lag]

5. A balanced three-phase star-connected load of 150 kW takes a leading current of 100 A with a line voltage of 1100 V, 50 Hz. Find the circuit constants of the load per phase.

   [R = 5 Ω, C = 810 μF]

6. A three wire, three phase supply feeds a load consisting of 3 equal resistors. By how much is the load reduced if one of the resistors be removed,

   (a) when the load is star-connected, and

   (b) when the load is delta-connected ?

   [(a) 50% and (b) 33.33%]

7. Three identical coils, symmetrically arranged in space, are star-connected to a 400 V, 50 Hz, three phase supply. Each coil has resistance and inductance of 100 Ω and 0.8 H respectively, while the mutual inductance between each pair of coils is 0.3 H. Calculate the current taken by each coil and its power factor.

   [1.24 A, 0.537 lag]