EEE270
Three-Phase Systems
Study Questions

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Q1. A balanced three-phase star-connected load has a per-phase impedance of Z=(10+j15) Ω. The load is supplied by a 400 V (rms), 50 Hz, three-phase source. Calculate:
a) Phase voltage
b) Phase current
c) Line current
d) Total real power
e) Total reactive power
f) Total apparent power
g) Power factor and its type

Q2. A balanced three-phase delta-connected load has a per-phase impedance of Z=(20-j13) Ω. The load is supplied by a 800 V (peak), 60 Hz, three-phase source. Calculate:
a) Phase voltage
b) Phase current
c) Line current
d) Total real power
e) Total reactive power
f) Total apparent power
g) Power factor and its type

Q3. A balanced three-phase power system consists of a balanced three-phase Y-connected source that supplies power at a line-to-line voltage of 500 V (rms) and a frequency of 50 Hz. The source is connected to a three-phase transmission line. Each line conductor has an impedance of (0.5 + j1) Ω. Two balanced three-phase loads are connected in parallel at the receiving end of the line. Load 1 is Y-connected with a per-phase impedance of (23 + j17) Ω and Load 2 is Δ-connected with a phase impedance of (35 - j19) Ω. Answer the following questions:
a) Draw the single-line diagram of the system, indicating all components and their parameters.
b) Calculate the total line current at the source side.
c) Determine the phase and line currents for both Load 1 and Load 2.
d) Find the total power (real, reactive, and apparent) consumed by the loads.
e) Calculate the total power loss in the transmission line.
f) Determine the efficiency of the power system (from the source to the loads).
g) Find the power factor of Load 1 and its type.
h) Find the power factor of Load 2 and its type.

Q4. A balanced three-phase wye-connected voltage source has a voltage at phase-a, Va(t) = 1000cos(wt-25) volts. Answer the following questions:
a) If this source has positive sequence, determine Va, Vb, and Vc in both phasor and time domain.
b) If this source has negative sequence, determine Va, Vb, and Vc in both phasor and time domain.
c) Draw the voltage vectors found in part (a).
d) Draw the voltage vectors found in part (b).

Q5. Show that this equation is correct for three-phase balanced voltage set.

$$V_m \angle 0^\circ + V_m \angle -120^\circ + V_m \angle +120^\circ = 0$$

Q6. A balanced three-phase wye-connected voltage source has a voltage at phase-a, Va(t) = 696.45sin(wt+113) volts. Answer the following questions:

a) If this source has positive sequence, determine Va, Vb, and Vc in both phasor and time domain.
b) If this source has negative sequence, determine Va, Vb, and Vc in both phasor and time domain.
c) Draw the voltage vectors found in part (a).
d) Draw the voltage vectors found in part (b).

Q7. A balanced three-phase delta-connected load (3+j8 ohm/ph) has a line-to-line voltage VAB of 100 volts rms with a phase angle of 7.0 degrees. If it is supplied from a positive sequence three-phase source, Answer the following questions:

a) Determine VBC and VCA.
b) Draw voltage vectors VAB, VBC, VCA.
c) Determine phase currents and draw their vectors.
d) Determine line currents and draw their vectors.
e) Determine real power consumed by this load.
f) Determine reactive power consumed or delivered by this load.
g) Determine apparent power of this load.
h) Determine complex power of this load.
i) Find the power factor and its type.

Q8. A balanced three-phase Y-connected load (100+j50 ohm/ph) has a line-to-line voltage VCA of 440 volts peak with a phase angle of -136.87 degrees. If it is supplied from a negative sequence three-phase source, Answer the following questions:

a) Determine VAB and VBC.
b) Draw voltage vectors VAB, VBC, VCA.
c) Determine VAN, VBN, VCN
d) Draw voltage vectors VAN, VBN, VCN.
e) Determine phase currents and draw their vectors.
f) Determine line currents and draw their vectors.
g) Determine real power consumed by this load.
h) Determine reactive power consumed or delivered by this load.
i) Determine apparent power of this load.
j) Determine complex power of this load.
k) Find the power factor and its type.

Q9. A balanced three-phase Y-connected generator with a negative phase sequence has an impedance of 0.25 + j0.533 Ω/φ and an internal voltage of 175 V/φ. The generator feeds a balanced three-phase wye-connected load having an impedance of 40 + j15.5 Ω/φ. The impedance of the line connecting the generator to the load is 0.72 + j1.62 Ω/φ. The a-phase internal voltage of the generator is specified as the reference phasor. Answer the following questions:

a) Construct the single-phase equivalent circuit of the power system.
b) Calculate the current at each phase of the line.
c) Calculate the line and phase voltages of the load. (at the end of the line)
d) Calculate the line and phase voltages of the generator. (at the beginning of the line)
e) Determine real power consumed by the load.
f) Determine reactive power consumed or delivered by the load.
g) Determine apparent power of the load.
h) Determine complex power of the load.
i) Find the power factor of the load and its type.
j) Find the power factor of the generator and its type.
k) Determine real power provided by the generator.
l) Determine reactive power consumed or delivered by the generator.
m) Determine apparent power of the generator.
n) Determine complex power of the generator.