

EEE270

Three-Phase Systems

Study Questions

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Q1. A balanced three-phase star-connected load has a per-phase impedance of $Z=(10+j15) \Omega$. 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 $Z=(20-j13) \Omega$. 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 $(0.5 + j1) \Omega$. 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 $(23 + j17) \Omega$ and Load 2 is Δ -connected with a phase impedance of $(35 - j19) \Omega$. 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, $V_a(t) = 1000\cos(\omega t - 25)$ volts. Answer the following questions:

- a) If this source has positive sequence, determine V_a , V_b , and V_c in both phasor and time domain.
- b) If this source has negative sequence, determine V_a , V_b , and V_c 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, $V_a(t) = 696.45\sin(\omega t + 113)$ volts. Answer the following questions:

- a) If this source has positive sequence, determine V_a , V_b , and V_c in both phasor and time domain.
- b) If this source has negative sequence, determine V_a , V_b , and V_c 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 V_{AB} 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 V_{BC} and V_{CA} .
- b) Draw voltage vectors V_{AB} , V_{BC} , V_{CA} .
- 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 V_{CA} 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 V_{AB} and V_{BC} .
- b) Draw voltage vectors V_{AB} , V_{BC} , V_{CA} .
- c) Determine V_{AN} , V_{BN} , V_{CN} .
- d) Draw voltage vectors V_{AN} , V_{BN} , V_{CN} .
- 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 negative positive 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.