THREE PHASE CIRCUITS

Theory Questions

1. List the advantages of three phase system.
2. Obtain the relation between phase and line quantities in a balanced star/delta connected system.

Numericals

1. A balanced load of (8+j6)Ω/ph is connected in **star** across 3-Φ, 400V, 50Hz supply. Find the line current, active power, reactive power, apparent power and pf. (Answer: 23.09A, 12.8kW, 9.6kvar, 16kVA, 0.8)

2. A balanced load of (8+j6)Ω/ph is connected in **delta** across 3-Φ, 400V, 50Hz supply. Find the line current, active power, reactive power, apparent power and pf. (Answer: 69.28A, 38.4kW, 28.8kvar, 48kVA, 0.8)

   Note: Observe the ratio of line currents, power from Q1 and Q2

3. Three identical impedances connected in star across a balanced three-phase supply consume 300W and take a current of 10A. Find the phase current, line current and power consumed if the same impedances were connected in delta across the same supply. (Answer: 17.32A, 30A, 900W)

4. A **star** connected load consists of 25Ω resistance in series with 15mH inductance in each phase. If the supply is 415V, 60Hz, find line current, power & pf. (Answer: 9.26A, 6.5KW, 0.975)

5. A **delta** connected load consists of 25Ω resistance in series with 15mH inductance in each phase. If the supply is 415V, 60Hz, find line current, power & pf. (Answer: 28.04A, 19.65KW, 0.975)

6. Three coils each with impedance Z are star connected and takes 150kW with a leading line current of 100A at a line Voltage of 1100V, 50Hz supply. Find the circuit constants. (Answer: 5Ω, 812μF)

7. A three-phase delta connected load consumes a power of 200kW taking a lagging current of 200A at a line Voltage of 1100V, 50Hz. Find the parameters of each phase. What would be the power consumed if the load were connected in star? (Answer: 5Ω, 25.8mH, 66.66kW)

ALTERNATOR/SYNCHRONOUS GENERATOR

Theory Questions

1. Explain with a neat diagram, constructional features of (i) salient pole type alternator, (ii) cylindrical pole type alternator. Mention the merits and demerits of each type and mention their applications.
2. Explain the principle of operation of an alternator and develop the expression for frequency.
3. Obtain the expression for emf equation of an alternator/synchronous generator with usual notations.

Numericals

1. A 12-pole 5rps, star connected alternator has 60 slots with 20 conductors/slot. Flux/pole is 0.02Wb, sinusoidally distributed. Winding factor is 0.97. Find (a) frequency, (b) phase emf and (c) line emf. (Answer: 30Hz, 516.82V, 895.15V)

2. A 3ϕ, 16-pole alternator has a star-connected winding with 144 slots and 10 conductors per slot. The flux per pole is 0.03Wb, sine-distributed, and the speed is 375rpm. Find the frequency, the phase and line electromotive forces. (Hint: K_w=1) (Answer: 50Hz, 1598.4V, 2768.51V)

3. A 6-pole, 3ϕ, 50Hz alternator has 12 slots per pole and 4 conductors per slot. A flux per pole of 25mWb is sinusoidally distributed along the air-gap. Determine the line emf if the alternator is star-connected. Given: Winding Factor K_d = 0.96; Pitch Factor K_c=1 (Answer: 442.98V)

4. A 3ϕ, star-connected alternator has the following data: line voltage required to be generated on open-circuit = 4000V (at 50Hz); speed = 500 rpm; stator slots/pole/phase = 3; conductors/slot=12. Calculate (i) number of poles, (ii) useful flux/pole. Assume all conductors/phase to be connected in series and the coil to be full-pitch. (Answer: 12, 48mWb)

5. Find the number of armature conductors in series per phase required for the armature of a 3ϕ, 10-pole, 50Hz alternator with 90 slots. The winding is to be star-connected to give a line voltage of 11000V. The flux per pole is about 0.16Wb. (Hint: Z_{ph} should be a multiple of slots per phase) (Answer: 360)

6. Calculate the speed and open-circuit line and phase voltages of a 4-pole, 3 phase 50Hz star-connected alternator with 36 slots and 30 conductors per slot. The flux per pole is 0.05Wb sinusoidally distributed. Assume winding factor to be 0.96. (Answer: 1500rpm, 1918.08V, 3322.21V)

THREE PHASE INDUCTION MOTOR

Theory Questions

1. Explain with a neat diagram, construction of (i) squirrel cage induction motor, (ii) slip-ring (phase wound) induction motor. Mention the merits and demerits of each type and mention their applications.
2. Explain the principle of operation of three phase induction motor.
3. Define the term slip with respect to induction motor.
4. Can an induction motor run at synchronous speed? Explain.
5. Explain the concept of Rotating Magnetic Field.

Numericals

1. A three phase induction motor is wound for four poles and is supplied from a 50Hz system. Calculate: (i) the synchronous speed, (ii) the speed of the rotor when the slip is 4%, (iii) the rotor frequency when the speed of the rotor is 600rpm. (Answer: 1500rpm, 1440rpm, 30Hz)

2. The frequency of emf in the stator of a 4-pole induction motor is 50Hz, and that in the rotor is 1Hz. What is the slip and speed? (Answer: 0.02, 1470rpm)

3. In a 6-pole, 50Hz, 3-ϕ induction motor running on full load, the rotor emf makes 90 complete cycles/minute. Find the slip and full-load speed. (Answer: 0.03, 970rpm)

4. A 6-pole, 3-ϕ induction motor runs at 950rpm from a 50Hz supply. Find the slip and the number of complete cycles of the rotor emf per minute. (Answer: 0.05, 150)

5. A 6-pole induction motor is supplied by a 10-pole alternator which is driven at 600rpm. If the induction motor is running at 970rpm, determine its percentage slip. (Answer: 3%)

6. A 12-pole, 3ϕ alternator is driven by a 6-pole, 50Hz, 440V 3-phase induction motor running at a slip of 3%. Find the frequency of emf generated by the alternator. (Answer: 97Hz)

7. A 6-pole alternator is driven at 1200rpm. What is the frequency of the generated emf. If this alternator supplies power to a 10-pole induction motor, find its speed when slip is 3%. (Answer: 60Hz, 698.4rpm)

8. A 12-pole 3ϕ alternator is coupled to an engine running at 500rpm. It supplies an Induction Motor which has a full load speed of 1440rpm. Find the percentage slip and the number of poles of the motor. (Answer: 4%, 4)