Module 19 Units 1-3 Three-Phase Transformers

1. What is the difference between a three-phase transformer and a bank of single-phase transformers? Windings from all three phases are wound on the same core in a three-phase transformer. Primary and secondary windings of each phase are on a separate core in a bank of single-phase transformers.

2. What are the four different connection configurations for a three-phase transformer? Wye-wye, wye-delta, delta-delta, and delta-wye.

3. What are the advantages of a three-phase transformer? Smaller, lighter, more efficient, cheaper, and easier to install.

4. What are the advantages of a bank of single-phase transformers connected for three-phase operation? Can operate in an emergency with one unit down for repair. (reduced capacity) Cheaper to repair than three-phase. Spare unit is cheaper than three-phase unit.

5. What are the advantages of a wye-wye connection? Less insulation required in transformer because of the common grounding point. (reduced voltage)

6. Which terminal on a transformer winding is typically connected to the neutral or grounded conductor? (primary and secondary) H2 & X2

7. What is the phase displacement in a transformer? 0° for Wye-wye and delta-delta, 30° for wye-delta and delta-wye.

8. What is the phase displacement angle in wye-wye connected transformers? 0°

9. What is the phase displacement angle in delta-wye connected transformers? 30°

10. When drawing the first phasor on the high side of a transformer, which terminal is located at the bottom? (H1 or H2)
11. How many degrees apart are phasors drawn in three-phase transformer diagrams?
   120°

12. How are neutral points labeled on a transformer voltage diagram? N

13. What is the result of reversing the leads for one winding of a three-phase transformer? Phase angles and voltages become unbalanced.

14. Other than incorrect voltages, what other effect will reversing the leads in one phase of a three-phase transformer have on the circuit? Neutral conductors may be overloaded.

15. What test should be done on a three-phase transformer after it is connected and before the load is applied? Balanced voltages.

16. Where is a delta-delta connection for transformers typically used? Medium voltage range where a neutral is not required.

17. Where is the “A” phase placed when drawing a diagram for grouping individual transformers to form a three-phase bank? 30° off the horizon.

18. Is a transformer bank with mixed polarity windings connected differently from one with all the same polarity? No

19. Is the line-to-line voltage ratio for a three-phase bank of transformers the same as the ratio of the individual units? Yes (Delta-to-delta)

20. What is a “mesh” or “delta-closure” test? Voltmeter placed in the final delta connection on the secondary.

21. What value will a voltmeter read in a “mesh” test if the transformer connections are correct? Zero in theory without harmonics.
22. What value will a voltmeter read in a “mesh” test if the transformer connections are incorrect? **Double line voltage.**

23. What precaution must be taken when a transformer is connected with a primary and secondary phase shift of 180 degrees? **Do not connect a delta-delta with a phase shift. CEC rule.**

24. What requirement does the CEC make for delta-delta three-phase transformer banks? **0° phase shift**

25. What is a wye-delta connection typically used for? **Transform high to medium voltage where a neutral is not required.**

26. With a proper wye-delta connection, which side leads the other by 30 degrees? **High side.**

27. In the primary of a wye-delta connected transformer, what is the phase voltage equal to? **\( \sqrt{3} \times I_{\text{Line}} \)**

28. In the secondary of a wye-delta connected transformer, what is the phase voltage equal to? **Line voltage.**

29. What is the most common transformer connection for supplying low voltage distribution systems? **Delta-wye.** Why? **Supplies both single-phase and three-phase loads. Grounding point limits voltage to ground on line conductor during a fault.**

30. Why is it important to use the proper voltage diagram for connecting transformers? **So they can be paralleled with other properly connected transformers.**
31. What is the angle from the horizontal for drawing the first vector in a delta connected transformer? 60°

32. Where is the “A” phase transformer located in a wiring diagram for a three-phase bank? Left.

33. On a standard wiring diagram for a delta connected transformer bank, which terminal of which windings are attached to phase A? H₁ of Phase A transformer and H₂ of Phase C transformer.

34. On a standard wiring diagram for a delta connected transformer bank, which terminal of which windings are attached to phase “B”? H₂ of Phase A and H₁ of Phase B.

35. On a standard wiring diagram for a delta connected transformer bank, which terminal of which windings are attached to phase “C”? H₂ of Phase B and H₁ of Phase C.

36. On a wye connected secondary of a step-up transformer, which terminals are connected to the neutral? The three H₂.

37. On a wye connected secondary of a step-down transformer, which terminals are connected to the neutral? The three X₁.

38. What is a three-phase, four-wire, delta connected transformer? The secondary of one transformer is center tapped and grounded.

39. What is the CEC requirement for the “high” leg of a three-phase, four-wire, delta connected transformer? Must be phase “A” and must be in a separate compartment from the grounded conductor.
40. When is an open delta transformer a good option? 1. Temporarily supply three-phase power when one transformer is out of service. 2. Initially supply a system that will expand in the future. 3. Supply loads where most of the requirement is for single-phase and only a small amount of three-phase is needed.

41. What percentage of the full load of a three-phase, closed delta transformer will an open delta supply? 57.7%

42. Where is an open wye-open delta transformer bank used? Rural areas where most of the demand is single-phase.

**Unit 2**

1. Why is it possible to make an autotransformer smaller and lighter than other types of transformers? **Shared coils. (less copper and less core)**

2. What are the main advantages of the autotransformer? (Other than smaller and lighter) **Cheaper to produce, more efficient, and better voltage regulation.**

3. What are the main disadvantages of an autotransformer? 1. Higher fault currents. 2. No isolation between primary and secondary. 3. Open in the shared winding will impress primary voltage across secondary load.

4. What hazard is associated with autotransformers? **Open in the shared winding will impress primary voltage across secondary load.**

5. Why is a wye connected autotransformer not typically used to supply single-phase loads? **Voltage imbalance.**

6. What are the advantages and disadvantages of a wye-connected autotransformer? Simple and efficient with no phase displacement. **Harmonics can cause insulation problems if not properly grounded.**
7. What is the maximum ratio for a delta-connected autotransformer? 1:2 or 2:1

8. What is one use of an open-delta autotransformer? Reduced-voltage starter for small three-phase motor.

9. Which type of delta autotransformer must be used for a ratio of 3:1? Extended-Delta.

10. What is the main advantage of the zig-zag delta autotransformer? Provide a neutral or grounding point in a three wire delta system.

11. What is a compensator? Autotransformer used to start a large AC Motor.

12. Which transformer is typically used to control a 240 V three-phase motor from a 208 V three-phase supply? Buck-boost transformers.

13. What does “buck” and “boost” mean? Buck means reduce or go against. Boost means to increase or add to.

14. What does the meter connected in the secondary of a potential transformer actually measure? Potential difference between one line and neutral or between two lines divided by the transformer ratio.

15. What are the two types of connection for a potential transformer? Line to line and line to neutral.

16. How are the current transformers connected into the lines? Series.

17. What do ammeters, connected to the secondary of current transformers, measure? Current being conducted in the lines at those points divided by the transformer ratio.

18. Can the secondary of a current transformer be opened for work or maintenance? Yes, but you must short it out first.

20. How many watt elements are required to measure power in a three-phase circuit? One less than the number of conductors in the system. (three for four wire three-phase)

21. What is the “watt multiplier” for calculating power in a circuit? *PT turns ratio multiplied by the CT turns ratio.*

22. Why are current transformers used on motor circuits? *Reduce the size and cost of overload relays and heaters.*

23. How is the fault current from the neutral of the zig-zag ground-fault alarm limited? *Resistor in series with the neutral ground.*