1. What is the most widely used three-phase service entrance system? Three-phase, four-wire.

2. What are the three most common voltage combinations for three-phase, four-wire systems? 120/208, 277/480, and 347/600.

3. How much less copper is required to supply the same load power with a three-phase, four-wire system compared to a single-phase system? 25%.

4. What are the two color choices for the conductor connected to the star point of a wye system? White or natural grey.

5. Identified circuit conductors up to what size are required to be identified throughout the entire length? No.2 AWG.

6. What is the most common use for the three-wire, delta connected distribution system? Commercial and industrial buildings with substantial motor loads.

7. What are two distinct advantages of the three-wire, delta connected system? 1 less conductor from the transformer and system will not shut down with a single phase to ground fault.

8. What are the four requirements of grounding? Permanent and continuous path to ground, sufficient size to carry predictable fault currents for the period of time the overcurrent takes to operate, ground path impedance must be low enough so no dangerous voltage appears, and impedance must be low enough to operate the overcurrent device as quickly as possible.

9. What is the main purpose of grounding? Safety.
10. How is a circuit protected from accidental contact with another system?
   
   **Grounding**

11. Where must service entrance equipment be located? As close as practicable to the point of entry to the building

12. What is a service box? Approved assembly that houses the main disconnect and overcurrent protection

13. When are service conductors considered to be outside the building when actually they are inside? Surrounded by at least 50 mm of concrete

14. What are some of the most common sizes for service entrance switches? 100, 200, 400, 600, 800, and 1200

15. What are some advantages of using a circuit breaker instead of a fused disconnect for a main switch in a service entrance? Features like remote tripping and ground-fault protection can be added

16. What is the maximum size three-phase service entrance that does not require current transformers? 200A

17. What is the minimum size meter cabinet for current transformers? 20” x 20” x 10” (500x500x250mm) NSPI

18. At what point is the system neutral conductor to be grounded? Main Switch and supply

19. What CEC table is used to calculate the size of a system grounding conductor? 17

20. What CEC table is used to determine the size of an equipment bonding conductor? 16
21. When is it necessary to remove the bonding screw from a main switch or panel board? **Load side of the main switch**

22. What value is used to determine the size of the grounding conductor for an ungrounded, three-wire, delta system? **Amperage of the largest service conductors**

23. What value is used to determine the size of a bonding conductor? **Ampacity of largest ungrounded conductor**

24. What is a ground detection device for a three-wire, delta system? **Lights connected between each phase and ground**

25. How is a fault indicated on a ground detection device? **One light will go dim or out and the other two will be bright**

26. How is the line side of a current transformer indicated? **White dot**

27. Should the neutral conductor be bonded to the current transformer enclosure? **No**

28. What size grounding conductor is required for a 600 A, three-phase service entrance? (Four-wire) **No.1 AWG**

29. What size bonding conductor is required for a 200 amp motor control center? **No.6 AWG**

30. Equipment not marked as to percentage of load may be loaded to what percentage of the rated amperage? **80% copper and 70% aluminum**

31. Why is it important to balance the loads on each phase of a three-phase system? **Overcurrent devices may trip and unbalanced voltages may occur**

32. Calculate the minimum demand wattage for each apartment with the following information. **11,800W**

   - 12 Units with living space of 80 sq meters and 14 kW range.
- House panel with 2-5 kW dryers, 3 kW lighting load, and a 10 kW water heater.
- All suite and house loads are 120/208 single-phase. Main service is 120/208 three-phase.

\[
\begin{align*}
1^{st} & \text{ 45 M²} = 3500W \\
2^{nd} & \text{ 45 M²} = 1500W \\
\text{Range} &= 6800W \\
\text{Total Demand Unit} \frac{11,800}{208} &= 56.7A
\end{align*}
\]

\[
\begin{align*}
1^{st} \text{ Unit @ 100%} &= 11,800W \\
\text{Next 2 @ 65%} &= 15,340W \\
\text{Next 2 @ 40%} &= 9440W \\
\text{Next 7 @ 25%} &= 20,650W \\
\text{House Panel @ 75%} &= 17250W \\
\text{Total demand for service} &= 74,480W/(208 \times 1.73) = 207A
\end{align*}
\]

33. Calculate the demand wattage for the house panel in the information above.

17250W

34. Calculate the minimum allowable ampacity for the service conductors for the apartment building above. What size R90 wire is required if in a conduit? 207A

**Unit 2**

1. What is the CEC definition of a ground? Direct connect to earth through a through a grounding electrode

2. What is the definition of a branch circuit? That portion of wiring between a load and its branch circuit device

3. What is an isolating switch? Switch that is not to be operated when it is carrying a current

4. What is a neutral? Identified conductor of a single-phase three wire or three-phase four wire circuit intended to carry zero current under balanced conditions.
5. **What is a splitter?** Wiring enclosure containing busbars or terminals intended for supplying a number of branch circuits

6. **What is a code fuse?** Class H non-time delay 10000 Amp interrupting capacity

7. **What is an integral device?** Individual devices incorporated to form part of a complete unit

8. **What is service factor?** Multiplier added to the full load rating of a motor to indicate continuous operating capability

9. **What is a tap conductor?** Conductor smaller than the bus, splitter, or conductor supplying it

10. **What do the letters DP indicate on a motor nameplate?** Drip-proof

11. **What size copper conductor is required for a load of 78 amps if the insulation is R90 and there are three conductors in a conduit?** No.4 AWG

12. **What size aluminum conductor is required for a load of 120 amps if the insulation is TW75 and there are three conductors in a conduit?** No.1/0 AWG

13. **What is the maximum amperage rating for each No. 3 TW75 copper conductor if there are 3 in a pipe?** 100 A

14. **What is the maximum amperage rating for each No. 3 R90 copper conductor if there are 4 in a pipe?** 84 A

15. **Is the neutral conductor in a conduit counted for de-rating purposes?** Only carries the unbalanced load so it is not counted for de-rating

16. **What size aluminum conductor (R90) is required when the load is 149 amps, the ambient temperature is 40\(^\circ\)C, and there are three conductors in a pipe?** (165.5 A) No.4/0
17. What is a neutral conductor called when it is used with two phase conductors to supply a load? Common

18. What size aluminum conductor (R90 in conduit) is required to feed a three-phase 125 kVA, 120/208 V, demand load with an ambient temperature of 30°C? 600 kcmil

19. How is the size of the neutral conductor determined in a three-phase system? Must be capable of carrying the maximum unbalanced load

20. What is the standard color code for a three-phase system? A-Red, B-Black, C-Blue

21. What is the definition of a supply service? Portion of wiring from the power authority to the point of connection

22. Do the demand factors of section 8 apply to motors and transformers? No

23. When must a three-phase system be grounded? If voltage to ground does not exceed 150 or if there is a neutral conductor

24. What are the exceptions to the rule that a grounding conductor must be without joint or splice throughout the entire length? Bus bars, thermit-weld joints, and compression joints installed with proper tools

25. What is the requirement for bare conductors, larger than No.8 AWG run in concrete? Protected from physical damage where they enter and exit

26. A commercial building has a demand load of 190 kVA, 120/208 V, three-phase. What is the minimum allowable amperage for the service conductors? 528 A

27. What size service is required? (Above) 800 A

28. What size conductors (R90 copper) are required for the service? (In pipe) (Above) 2x500 kcmil

29. What size grounding conductor is required? (Above) No.1/0 AWG
30. Which parts of an electrical system must be bonded together? All metal non-current-carrying parts

31. What is the minimum size bonding conductor for gas pipes and metallic sewer lines? No. 6 AWG

32. What are three methods for providing mechanical protection for underground conductors? Sand, concrete, or wood plank

33. What is the main advantage of paralleling conductors? Ease of installation

34. What precautions must be taken when paralleling conductors? Free of splices, same wire size, same insulation type, same length, terminated in approved connectors

35. What is a raceway? Any channel designed to house conductors

36. What size conduit is required for 13 No.10 AWG (TW75) copper conductors? 27

37. What size conduit is required for 10 No.8 AWG (R90) copper conductors? 35

38. What size conduit is required for 3 No. 6 AWG (R90) copper conductors and 3 No. 3 AWG (R90) copper conductors? \( (37.98 \times 3)113.94 + (61.99 \times 3)185.97 = 299.91 \) (1 ¼)

39. What is the demand wattage for a hospital with outside measurements of 100 M long and 50 M wide? Intensive care units total 500 M² inside the total area.

\[ 100 \times 50 = 5000 \text{M}^2 \times 20 \text{W/M}^2 = 100,000 \text{W} + (500 \text{M}^2 \times 100 \text{W/M}^2) = 150,000 \text{W} \]

40. What is the watts-per-meter for the question above? 20 W/M² for regular and 100 W/M² for Intensive care

41. What is the demand wattage for an apartment with an area of 110 M², 3 kW water heater, 5 kW dryer, and 15 kW of electric heat? (Individual room control) 1st

\[ 45 \text{M}^2 = 3500 \text{W}, \text{Next 45M}^2 = 1500 \text{W}, \text{Next 90M}^2 = 1000 \text{W}, \text{Electric heat} = 13750 \text{W} \]

Water heater=750W, Dryer=1250W, No Range=6000W 27750W
42. What is the minimum allowable ampacity for the feeder conductors if the system is 120/208 V single-phase? (Above) 133.4 A

43. What is the demand wattage for 10 of the apartments above in a single building? First

   Unit @ 100% = 14,000W
   Second 2 units @ 65% = 18,200W
   Next 2 units @ 40% = 11,200W
   Next 5 units @ 25% = 17,500W
   Heat (first 10k @100% and balance at 75%) 115,000 W

   Total Watts 175,900

44. What is the minimum amperage rating for a conductor for this 120/208 three-phase service? (R90 Copper) \(175,900/1.73 \times 208 = 489\) A

45. What is the minimum size conductor for this service (R90)? 700 kcmil

46. What size service is required for the apartment complex? 500 A