Unit 2–Service Equipment

MULTIPLE CHOICE

1. Which type of transformer is the most common type used in unit substations that are indoors?
   a. liquid filled
   b. delta
   c. dry-type
   d. corner wye

   ANS: C PTS: 1 DIF: Easy REF: EWI p. 15
   BLM: Remember

2. What is the name of the part that is installed in a unit substation that provides a reliable method of terminating a high-voltage cable?
   a. terminal
   b. pothead
   c. bus
   d. tap

   ANS: B PTS: 1 DIF: Easy REF: EWI p. 15
   BLM: Remember

3. What is the least expensive means of high-voltage protection?
   a. fuses
   b. overload relay
   c. resistive insulator
   d. moulded case circuit breakers

   ANS: A PTS: 1 DIF: Easy REF: EWI p. 19
   BLM: Remember

4. Where in the *CEC* is information found regarding the maximum overcurrent ratings for transformers rated over 750 V?
   a. Section 12
   b. Section 14
   c. Section 26
   d. Section 36

   ANS: C
   CEC 26-252 and Table 50

   PTS: 1 DIF: Moderate REF: EWI p. 19 BLM: Higher Order

5. What is the maximum standard size overcurrent device permitted for a dry-type transformer with the following ratings on its nameplate: 150 kVA, primary 600 V, secondary 120/208 V, 3Ø, 3% Z?
   a. 200 A
   b. 250 A
   c. 300 A
   d. 350 A

   ANS: A
   CEC 26-256(1) and (3), Table 13
   I = VA / A = 150 000 / (600 × √3) = 144.34 A
   144.34 × 125% = 180.43 A = 200 A fuse or circuit breaker

   PTS: 1 DIF: Challenging REF: EWI p. 21 BLM: Higher Order

6. What must be done when a metal raceway enters through the base of a unit substation, and not through the metal structure?
   a. Install a ground fault detector.
   b. Connect the conduit directly to neutral.
   c. Bond the conduit to the grounding system.
   d. Connect the neutral directly to the ground.

   ANS: C
   CEC 10-814

   PTS: 1 DIF: Moderate REF: EWI p. 23 BLM: Remember

7. What wiring method is specified to be run from the switchboard to the metering cabinet in the main electrical room?
   a. the wiring for the ground fault system
   b. a No. 4 AWG ground in a 21 mm conduit
   c. the wiring for the dpm
   d. two 35 mm conduits

   ANS: D
   Drawing E6

   PTS: 1 DIF: Moderate REF: EWI p. 23 BLM: Higher Order

8. When does the local utility begin to impose penalties for power factor issues?
   a. when the power factor goes below 70%
   b. when the power factor goes below 80%
   c. when the power factor goes below 90%
   d. when the power factor goes below 100%

   ANS: C
   Figure 2-13

   PTS: 1 DIF: Easy REF: EWI p. 24 BLM: Remember

9. What is the term used to describe the potential difference between two points on the earth's surface, 1 m apart, in the direction of maximum voltage gradient?
   a. grounding electrode
   b. touch voltage
   c. step voltage
   d. voltage-to-ground

   ANS: C
   CEC 36-002

   PTS: 1 DIF: Moderate REF: EWI p. 25 BLM: Higher Order

10. What is the minimum distance that a ground electrode system must extend, beyond the fenced perimeter of a high-voltage substation?
   a. 1 metre
   b. 2 metres
   c. 3 metres
   d. 4 metres

   ANS: A
   CEC 36-312(1)

   PTS: 1 DIF: Moderate REF: EWI p. 26 BLM: Higher Order

11. How many ground rod electrodes are required for a high-voltage substation, and what minimum size must they be?
   a. at least four 19 mm × 3 m ground rods
   b. at least four 19 mm × 6 m ground rods
   c. at least two 25 mm × 3 m ground rods
   d. at least two 25 mm × 6 m ground rods

   ANS: A
   CEC 36-302(1)(a)

   PTS: 1 DIF: Moderate REF: EWI p. 26 BLM: Higher Order

12. What is the minimum conductor size for interconnecting the rods of an outdoor substation's ground electrode?
   a. No. 1/0 AWG
   b. No. 2/0 AWG
   c. No. 3/0 AWG
   d. No. 4/0 AWG

   ANS: B
   CEC 36-302(1)(b)

   PTS: 1 DIF: Moderate REF: EWI p. 26 BLM: Higher Order

13. When terminating a medium-voltage cable, which of the following is used to minimize the electrical stresses at the point where the insulation shield ends?
    a. stress cone
    b. tap
    c. surge arrester
    d. concentric neutral

    ANS: A PTS: 1 DIF: Easy REF: EWI p. 31
    BLM: Remember

14. What is this formula used for?
    $T_m = K \times n \times CMA$
    a. actual pulling tension on a conductor
    b. actual voltage drop for underground conductors
    c. maximum allowable pulling tension for a conductor
    d. allowable conductor ampacity for underground conductors

    ANS: C PTS: 1 DIF: Easy REF: EWI p. 32
    BLM: Remember

15. What is the size of the DB2 conduit specified for the duct bank running from the industrial building's new pad-mounted transformers to the main switchgear?
    a. 16
    b. 41
    c. 78
    d. 103

    ANS: A
    Drawing E9

    PTS: 1 DIF: Moderate REF: EWI p. 32 BLM: Higher Order

16. What is the actual pulling tension for four conductors in a 20 m straight pull of conduit if the conductors weigh 1.5 kg/m each?
    a. 15 kg
    b. 30 kg
    c. 60 kg
    d. 120 kg

    ANS: C
    $T_S = L \times W \times f = 20 \times (1.5 \times 4) \times .5 = 60$ kg

    PTS: 1 DIF: Challenging REF: EWI p. 33 BLM: Higher Order

SHORT ANSWER

1. Explain what type of overcurrent protection is installed in the industrial building's power distribution system.

   ANS:
   High-voltage current-limiting fuses are installed in this industrial building. The fuse selected must meet the predetermined voltage, frequency, and current requirements for the installation. Fuses are available in both 25 Hz and 60 Hz systems and for voltage ratings of 2400 V and up.

   PTS: 1 DIF: Easy REF: EWI p. 18 BLM: Remember

2. Explain the difference between primary and secondary when related to transformers, and what could possibly occur if connected incorrectly.

   ANS:
   There are two sides to every transformer: the primary and the secondary. The primary is always connected to the voltage source, while the secondary is always connected to the load. This explains why in most cases the primary voltage is higher than the secondary voltage. Example: A step down 600 V to 120/208 V transformer is the one that most students are familiar with. If someone was to accidentally connect the line side to the secondary side and the secondary to the line side, the opposite would happen, so if 600 V was connected on the secondary, out of the primary terminals you would get approximately 1800 V.

   PTS: 1 DIF: Easy REF: EWI p. 19 BLM: Remember

3. Explain how a fence around a substation would be grounded.

   ANS:
   Referring to *CEC* 36-312:
   From the station ground, a min No. 2/0 AWG copper conductor must be run to each corner post, gate post, and end post. Intermediate posts must be grounded at every 12 m.
   The gate post must be grounded to the gate by a No. 2/0 AWG flexible copper conductor.
   Using, once again, a No. 2/0 AWG copper conductor, the fence and posts are bonded to the bottom tension wire, weaving the conductor through the fence at least twice, then connected to the top fence rail and the barbed wire strands.

   PTS: 1 DIF: Moderate REF: EWI p. 27 BLM: Higher Order

4. List and explain five trade practices that should be observed when installing conductors and cables into an underground raceway.

   ANS:
   - Determine the best direction to pull, based on pulling tension calculations.
   - Locate the cable reel so that pulling tension is minimized.
   - Choose a pulling eye or grip that is sized correctly for the conductors.
   - Select a rope that has low stretch characteristics and adequate breaking strength.
   - Measure and keep an eye on the pulling tension by installing a dynamometer.
   - Before the pull, swab the conduit and make sure it is free of debris or any other obstructions.
   - Use a pulling lubricant on the conductors before and during to minimize friction.
   - Make use of radios or cell phones for communicating on a long run.
   - Try not to stop the pull partway through (which would mean sudden jerks and stress on the rope and conductors when restarting)
   - Once the conductors have been installed, seal off the ends of the raceway so water or other debris does not get in.
   - Check the conductors with a megger after they are installed.

   PTS: 1 DIF: Moderate REF: EWI p. 29 BLM: Remember

5. Determine the allowable ampacity for each of the copper 500 kcmil conductors in the following underground duct bank: The conductors are run in parallel, four runs of four conductors each, in an underground PVC duct bank, from a pad mounted transformer to a switchboard located in a building, and the conductors are terminated in a circuit breaker.

   ANS:
   Using *CEC* Diagram B4-4 and Table D14B, the allowable ampacity for each conductor is 319 A.

   PTS: 1 DIF: Challenging REF: EWI p. 32 BLM: Higher Order

