RED SEAL EXAM PREP

442A Industrial Electrician

Free 49-Question Mock Exam

Practice for the Red Seal / Certificate of Qualification exam

Pass mark: 70% · Aligned to the published occupational standard topic weightings
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Mock Exam — answer all questions, then check the key

Q1. **What is a PLC scan cycle?**

A) The time between PLC maintenance intervals

B) The frequency of communication to HMI screens

C) The time for the PLC to restart after a power failure

D) The read-execute-write cycle repeated continuously

Q2. **What is power factor in AC circuits and why is low power factor a problem?**

A) The ratio of real power to apparent power

B) Power factor measures efficiency of motors only

C) Low power factor causes motors to run faster than synchronous speed

D) Power factor affects DC circuits only

Q3. **A 442A electrician finds a 3-phase induction motor drawing Phase A=28A, Phase B=31A, Phase C=24A while running unloaded at rated voltage. What is the MOST likely cause?**

A) Single-phasing from a blown control fuse

B) Voltage unbalance at the supply terminals

C) Motor is overloaded beyond nameplate rating

D) Worn motor bearings causing mechanical drag

Q4. **What is a current transformer (CT) and how is it used in metering?**

A) A clamp meter that measures current without contact

B) A transformer that converts AC to DC for measurement

C) A transformer reducing primary current to 5A or 1A for metering

D) A transformer used for variable current control in motor drives

Q5. **What is the purpose of bonding in electrical systems?**

A) To increase current-carrying capacity of conductors

B) To protect against voltage surges from lightning

C) To equalize voltage between phases

D) To provide a low-impedance path for fault current

Q6. **What is a phase rotation test and why is it performed before energizing large motors?**

A) To test the motor insulation resistance

B) To measure the voltage between phases

C) To measure motor speed before startup

D) To verify the supply phase sequence before startup

Q7. **A 442A electrician performs a polarization index (PI) test on a large 4.16kV motor. The 1-minute resistance is 80 MΩ and the 10-minute resistance is 120 MΩ. What is the PI and is the insulation acceptable?**

A) PI=0.67 — unacceptable, insulation has moisture or contamination

B) PI=1.5 — acceptable, insulation is dry and healthy

C) PI=1.5 — unacceptable, PI must be ≥ 2.0 for motors above 1 kV

D) PI=1.5 — borderline, monitor closely

Q8. **What is the purpose of a distribution transformer in an industrial facility?**

A) To step down supply voltage to utilization voltage

B) To filter harmonic currents from VFD drives

C) To generate electrical power on-site

D) To correct power factor for the plant

Q9. **What is a differential pressure (DP) transmitter used for?**

A) To measure flow or level by sensing a pressure difference

B) To measure absolute pressure in a vessel

C) To control the differential pressure in a boiler

D) To measure the voltage difference between two phases

Q10. **What is slip in an induction motor?**

A) The difference between synchronous and rotor speed

B) The starting current relative to full-load current

C) The mechanical efficiency of the motor

D) The difference between rated and measured voltage

Q11. **An RTD (Pt100) temperature sensor reads -40°C in an oven that is clearly at room temperature (~22°C). A technician measures approximately 84 Ω at the RTD terminals at the DCS. What is the MOST likely fault?**

A) RTD calibration drift from overheating

B) The DCS analog card has failed

C) RTD extension wires are partially shorted

D) RTD element has failed open

Q12. **What is personal protective equipment (PPE) required when working on live 480V equipment?**

A) Leather gloves and hard hat only

B) Arc-rated PPE with insulated gloves and tools

C) PPE is not required for 480V — it is considered low voltage

D) Safety glasses and work boots only

Q13. **What is impedance (Z) in AC circuits?**

A) The resistive component only of an AC circuit

B) The maximum current in an AC circuit

C) The total opposition to current flow in an AC circuit

D) The phase angle between voltage and current

Q14. **What happens if a current transformer (CT) secondary is open-circuited while the primary is energized?**

A) The CT primary current decreases to zero

B) The CT secondary trips the protective relay

C) Nothing — the CT simply stops measuring

D) Dangerously high voltage appears on the secondary

Q15. **What is the difference between a "fail open" (FO) and "fail closed" (FC) control valve?**

A) FO is for liquid service; FC is for gas service

B) FO opens at full stroke; FC closes at full stroke

C) FO opens on loss of air/power; FC closes on loss

D) FO uses a butterfly valve; FC uses a globe valve

Q16. **What is a timer instruction in PLC ladder logic?**

A) A module that synchronizes multiple PLCs

B) An instruction that sets a done bit after a preset time

C) An instruction that resets the PLC after a set time

D) A hardware clock module that controls machine cycles

Q17. **What is a control valve Cv (flow coefficient)?**

A) The valve's flow capacity at 1 psi pressure drop

B) The calibration verification number of the valve

C) The valve's closing velocity in m/s

D) The valve stroke in percentage per volt of signal

Q18. **What is the difference between AC and DC electricity?**

A) AC is only for power transmission; DC is for motors

B) DC is safer than AC for all applications

C) AC always has higher voltage than DC

D) AC reverses direction periodically; DC flows one way

Q19. **What is arc flash and what CSA standard governs arc flash safety?**

A) Electrical shock from AC systems; governed by CEC C22.1

B) Explosive energy release from an arc fault; governed by CSA Z462

C) Voltage surge in power lines; governed by IEEE 1584

D) Static discharge from rotating machinery; governed by CSA Z267

Q20. **What is program scan time and why does it matter in safety-critical applications?**

A) The time for the PLC to boot after power loss

B) The time between scheduled PLC maintenance — longer scan = more wear

C) The time for one complete scan cycle — limits response speed

D) The time for the PLC to communicate with the HMI

Q21. **What type of conduit is required in a Class I, Division 1 hazardous location?**

A) Rigid metal conduit (RMC)

B) EMT (electrical metallic tubing)

C) PVC conduit with explosion-proof fittings

D) TECK90 armoured cable

Q22. **A wound-rotor induction motor is connected with external resistance in the rotor circuit. After the resistance is short-circuited, motor RPM increases from 1,680 to 1,740 under the same load. What does this confirm?**

A) The motor was single-phasing before the resistance change

B) Synchronous speed of this motor is 1,740 RPM

C) The motor had a shorted stator winding

D) External resistance was increasing slip and reducing speed

Q23. **What is a bus bar in electrical distribution?**

A) A solid conductor forming a common connection point

B) A type of fuse used in high-current applications

C) The main communication network in a PLC system

D) A grounding conductor in a substation

Q24. **What is a delta-wye (Δ-Y) transformer connection and what is its advantage?**

A) Both delta and wye are identical in performance

B) Delta is for HV primary; Wye is only for motor loads

C) The wye secondary provides a neutral for single-phase loads

D) Wye primary reduces short circuit current; Delta secondary increases voltage

Q25. **What is an HMI in automation?**

A) Hydraulic Motor Interlock — a safety system

B) High Motor Interface — motor speed feedback device

C) Human-Machine Interface — operator display and controls

D) High-speed Memory Interface — PLC memory module

Q26. **What is the purpose of a neutral conductor in a 4-wire, 3-phase system (WYE)?**

A) To provide a return path for motor starting current

B) To carry unbalanced current and serve single-phase loads

C) To carry ground fault current to the electrode

D) To improve the system power factor

Q27. **What does FLA or FLC stand for on a motor nameplate?**

A) Full Load Amperes

B) Frequency Limit Adjustment

C) Fuse Load Allowance

D) Full Line Ampacity

Q28. **A 442A electrician measures a single-phase 120V AC circuit drawing 15A with a power factor of 0.75 lagging. What is the true (real) power consumed?**

A) 1,800 W (apparent power)

B) 1,800 VA

C) 1,350 W

D) 2,400 W

Q29. **What is a ground fault circuit interrupter (GFCI) and where is it required?**

A) An arc-flash energy protection device

B) A device that trips on ~5 mA current imbalance

C) A fuse that clears short circuits only

D) An overload protector for motor circuits

Q30. **A technician uses a clamp meter to measure current on a 3-phase motor with star (Y) connection. Each phase measures 18A. What is the line current feeding this motor?**

A) 10.4A (18 / √3)

B) 18A (line = phase)

C) 31.2A (18 × √3)

D) 54A (18 × 3)

Q31. **What is a wound rotor induction motor and its advantage over squirrel-cage type?**

A) A motor with rotor windings on slip rings, allowing external resistance control

B) A motor wound with aluminum conductors for lighter weight

C) A motor with additional windings for higher torque at all speeds

D) A motor with copper windings on the stator only — used for single-phase applications

Q32. **What is the minimum approach boundary (limited approach) for 600V AC equipment per CSA Z462?**

A) 300 mm (1 ft)

B) 1.05 m (3.5 ft)

C) 3.0 m (10 ft)

D) 4.5 m (15 ft)

Q33. **What is the purpose of a safety relay or safety PLC?**

A) To provide backup power when the main PLC fails

B) To protect PLC hardware from voltage spikes

C) To reset the PLC after an emergency stop event

D) To monitor safety functions and force a safe state on fault

Q34. **What is the formula for three-phase power?**

A) $P = V_L \times I_L / \sqrt{3}$

B) $P = V \times I$ (same as single phase)

C) $P = 3 \times V \times I \times PF$ (where V = line voltage)

D) $P = \sqrt{3} \times V_L \times I_L \times PF$ (line values)

Q35. **What is a 4–20 mA current loop signal used for?**

A) A power supply circuit for PLC modules

B) A motor control signal from a VFD

C) A communication protocol between PLCs

D) A standard analog signal for process variables

Q36. **What is a soft starter?**

A) An electronic device that ramps up voltage during starting

B) A motor with low-friction bearings for smooth starting

C) A magnetic starter with a slow-close contactor

D) A variable autotransformer for motor starting

Q37. **What is an equipotential bonding mat used for in industrial work?**

A) To store insulated tools between tasks

B) To protect workers from step and touch potential

C) To bond conduit to the earth electrode

D) To measure bonding conductor resistance

Q38. **What is the purpose of a dynamic braking resistor connected to a VFD?**

A) To protect the VFD from voltage spikes

B) To start the motor faster by providing additional energy

C) To improve power factor during motor starting

D) To dissipate regenerated energy as heat during deceleration

Q39. **What is the purpose of a motor's service factor (SF)?**

A) The multiplier for allowable continuous overload

B) The number of poles divided by frequency

C) The ratio of starting torque to full-load torque

D) The efficiency rating at full load

Q40. **What is a 2-wire vs 4-wire transmitter?**

A) 2-wire transmitters are for digital signals; 4-wire for analog

B) Wire count refers to the number of calibration points only

C) 2-wire is loop-powered; 4-wire has a separate power supply

D) 2-wire = only positive terminal; 4-wire = both terminals

Q41. **What is the purpose of a power factor correction capacitor bank?**

A) To supply reactive power locally

B) To store energy for emergency power

C) To regulate voltage at the service entrance

D) To filter voltage harmonics from VFDs

Q42. **Under CEC Section 28, how is motor branch-circuit overcurrent protection sized relative to the motor full-load current (FLC)?**

A) At 80% of the motor service factor current

B) Only Class J current-limiting fuses are permitted

C) Above FLC, using the Code multipliers

D) At exactly 100% of motor FLC

Q43. **What is the purpose of a star-delta (Y-Δ) starter?**

A) To vary motor speed by changing the number of poles

B) To allow the motor to run in both clockwise and counterclockwise directions

C) To step up voltage for high-voltage motor starting

D) To reduce starting current by starting in star, then switching to delta

Q44. **What is the role of a motor nameplate?**

A) To specify the recommended maintenance schedule

B) To identify the motor's warranty information

C) To provide decorative information only

D) To provide rated data for installation and protection

Q45. **A 4-20mA loop-powered transmitter reads 3.6mA with the process at 0% (minimum range). What does this indicate and what should the technician do FIRST?**

A) Transmitter fault — verify loop supply and zero trim

B) Normal — some transmitters operate below 4mA at process zero

C) Broken signal wire — replace immediately

D) PLC analog input card has failed

Q46. **A technician performs a voltage drop test on a 120V, 20A branch circuit supplying a load 50m from the panel. The voltage drop measured is 8V (6.7%). What corrective action should be taken per CEC requirements?**

A) Replace the load with a lower-power model

B) Add a voltage regulator at the load end

C) Increase conductor size to bring drop within CEC limits

D) No action needed — CEC allows up to 10% voltage drop

Q47. **What is a normally open (NO) contact in PLC ladder logic?**

A) A physical contact that is open by default in the field

B) A contact that passes logic when its reference bit is TRUE

C) A contact used only in emergency stop circuits

D) A contact that passes current only when its coil is de-energized

Q48. **What does CEC Section 2 address?**

A) Special occupancies

B) General rules and definitions

C) Wiring methods and materials

D) Installation methods for conductors

Q49. **What is HART protocol and what is its primary advantage?**

A) High-speed Analog Real-Time Transmission — faster than 4–20 mA

B) A wireless mesh protocol for field instruments

C) Hardwired Addressable Relay Technology system

D) Highway Addressable Remote Transducer protocol

Answer Key & Explanations

Q1. Answer: D

The PLC scan cycle consists of: (1) Read all input values to the input image table, (2) Execute the user program, (3) Write output values from the output image table to physical outputs, then repeat continuously.

Q2. Answer: A

Power factor (PF) = P/S = cos θ. Low PF (caused by inductive loads like motors) means current is out of phase with voltage. More current is needed for the same real power, increasing I^2R conductor losses and utility demand charges/penalties.

Q3. Answer: B

Even small voltage unbalance causes significant current unbalance. A 2% voltage unbalance can cause 6–10× current unbalance between phases. Bearings cause noise but not phase-unbalanced current. Single-phasing would show one phase near zero. Overload raises all phases proportionally.

Q4. Answer: C

Current transformers (CTs) step down large primary currents (e.g., 1000A) to a standardized 5A or 1A secondary for safe measurement by metering, energy meters, and protective relays.

Q5. Answer: D

Bonding connects all metallic enclosures, conduits, and equipment to the grounding system, ensuring fault current has a low-impedance return path that allows the OCPD (fuse/breaker) to trip quickly and clear the fault.

Q6. Answer: D

A phase rotation (sequence) tester verifies that the three phases are in the correct sequence (A-B-C or 1-2-3). Wrong phase sequence causes a 3-phase motor to start in the reverse direction, potentially causing equipment damage or injury.

Q7. Answer: D

PI = R_{10} min / R_1 min = 120/80 = 1.5. IEEE 43 states: PI <1.0 = unacceptable (shorted/wet); PI 1.0-2.0 = questionable/borderline for machines rated above 1 kV; PI ≥ 2.0 = acceptable for such machines. At 1.5 this 4.16 kV motor is borderline — not a clear pass and not a hard fail (option A): monitor/trend it, and clean and dry the windings, then re-test before returning it to service. It is NOT "dry and healthy" (that needs PI ≥ 2.0). For motors below 1 kV, a lower PI may still be acceptable.

Q8. Answer: A

Distribution transformers step down the high-voltage utility supply (e.g., 13.8 kV) to the utilization voltages used by plant equipment. Common industrial: 13.8 kV → 600V for large motors/feeders, 600V → 120/208V for lighting and controls.

Q9. Answer: A

DP transmitters measure the difference between two pressure taps. With an orifice plate restriction, DP indicates flow (square root relationship). For level measurement, DP corresponds to liquid column height × density.

Q10. Answer: A

Slip is expressed as a percentage: Slip = (Ns - Nr) / Ns × 100%. At no load, slip is small. At full load, typical slip is 2–5%. Slip allows the rotor conductors to experience a changing magnetic field, inducing the rotor current that creates torque.

Q11. Answer: C

A shorted RTD lead appears as lower resistance than actual temperature. A short circuit somewhere in the 3-wire RTD extension leads reduces measured resistance below actual, making the DCS calculate a lower (incorrect) temperature. Pt100 at 22°C ≈ 108.6 Ω, but at −40°C it is 84.27 Ω (IEC 60751) — the ~84 Ω measured means a partial short in the leads is bypassing ~25 Ω of the element's true resistance, so the DCS computes −40°C.

Q12. Answer: B

480V industrial systems can cause severe arc flash. Minimum PPE per CSA Z462 for energized work includes an arc-rated suit (minimum 8 cal/cm^2, per the incident energy analysis), a face shield, insulating gloves rated for the voltage, and insulated tools.

Q13. Answer: C

Impedance $Z = \sqrt{(R^2 + (XL\text{-}Xc)^2)}$. It is the complete opposition to AC current — the vector sum of resistance (R), inductive reactance (XL), and capacitive reactance (Xc) at a specific frequency.

Q14. Answer: D

With the secondary open, the primary current acts solely as magnetizing current, fully magnetizing the CT core. The core saturates and the collapsing magnetic flux induces extremely high, potentially lethal voltage spikes (thousands of volts) on the open secondary terminals.

Q15. Answer: C

Fail-safe position is determined by process safety analysis. Fail open (FO): the spring pushes the valve open on loss of instrument air (e.g., cooling water valves must stay open on failure). Fail closed (FC): the spring closes the valve (e.g., fuel gas valves must close on failure).

Q16. Answer: B

Timer instructions (TON = Timer On Delay, TOF = Timer Off Delay, RTO = Retentive Timer) count elapsed time and set output bits when the accumulated time reaches the preset value. Used for timed sequences, delay functions, and time-based control.

Q17. Answer: A

Cv is the flow capacity of a valve — the volume of water (US gallons per minute) that flows through it with a 1 psi pressure drop. Sizing: $Cv = Q \times \sqrt{(SG/\Delta P)}$ where Q is flow in gpm, SG is specific gravity, ΔP is pressure drop in psi. Larger Cv = larger flow capacity.

Q18. Answer: D

AC (alternating current) reverses polarity/direction at the supply frequency (60 Hz in North America = 120 reversals/second). DC (direct current) flows in one constant direction only. AC is used for power distribution; DC for electronics, batteries, and VFD internal circuits.

Q19. Answer: B

Arc flash is an explosive electrical discharge that releases intense heat (up to 20,000°C), pressure, and UV/IR radiation. CSA Z462 (Workplace Electrical Safety) establishes arc flash hazard analysis and PPE requirements.

Q20. Answer: C

Scan time — the duration of one complete read-execute-write cycle — determines how quickly the PLC and its control loop respond to process changes. In safety applications, if the scan time is too long, a hazardous condition may persist for longer than acceptable. Safety PLCs have deterministic, certified scan times.

Q21. Answer: A

Class I, Division 1 locations require rigid metal conduit (RMC) with explosion-proof fittings, or equivalent explosion-proof wiring methods and equipment. EMT is not approved for Division 1.

Q22. Answer: D

External rotor resistance increases slip, reducing speed. Wound-rotor motors use external resistance to limit starting current and control speed. When resistance is removed (short-circuited) for normal operation, slip decreases and speed approaches synchronous speed. 1,800 RPM synchronous at 60 Hz for a 4-pole motor; 1,740 RPM represents normal running slip.

Q23. Answer: A

Bus bars are solid flat or rectangular copper or aluminum conductors that carry large currents in switchgear, switchboards, and MCCs. Multiple circuits tap off the bus bar, which serves as their common connection point and is sized for the full load current.

Q24. Answer: C

A delta-wye (Δ-Y) transformer has the primary wound in delta (no neutral) and the secondary wound in wye (star) with a grounded neutral point. This provides a 4-wire system on the secondary, delivering both 3-phase line-to-line voltage (e.g., 600V L-L) and single-phase line-to-neutral voltage (e.g., 347V L-N = 600/√3) for grounding and single-phase loads. Wrong answers: wye-delta has the neutral on the primary side only and is typically used for motor loads or power factor correction; delta-delta has no neutral on either side (used for motor loads where no single-phase branch circuits are needed). The delta-wye configuration also blocks certain harmonic currents (triplen harmonics) from passing between primary and secondary. Red Seal point: 600V/347V systems in Canada use delta-wye transformers so that 347V single-phase branch circuits (lighting) can be supplied from the same transformer as 600V 3-phase motor loads.

Q25. Answer: C

An HMI (Human-Machine Interface) allows operators to monitor and control automated processes via touchscreens or panel displays. It shows process status, alarms, and trends, and allows setpoint entry.

Q26. Answer: B

In a 4-wire Wye system, the neutral carries the vector sum of the three-phase currents. For balanced loads, neutral current is zero. For unbalanced loads, it carries the difference. It also provides the line-to-neutral voltage reference for single-phase loads.

Q27. Answer: A

FLA (Full Load Amperes) or FLC (Full Load Current) is the motor's rated current drawn at nameplate voltage and full mechanical load. Used for sizing conductors, overload protection, and motor starter components.

Q28. Answer: C

Real power = V × I × PF = 120 × 15 × 0.75 = 1,350 W. Apparent power = V × I = 120 × 15 = 1,800 VA. Real power (watts) does actual work. The remaining 1,800 - 1,350 = 450 VAR is reactive power (stored/returned by inductance or capacitance). Power factor = cos θ = real/apparent = 0.75.

Q29. Answer: B

A GFCI monitors the difference between current on the hot and neutral conductors. When the imbalance exceeds 4–6 mA (indicating a ground fault or current through a person), it trips in <30 ms. GFCI protection is required in wet and damp locations.

Q30. Answer: B

In a star (Y) connected motor, line current equals phase current. In Y connection: I_line = I_phase = 18A. Only voltage differs: V_line = V_phase × √3. This is opposite to delta: in delta, I_line = I_phase × √3, but V_line = V_phase. The clamp meter on each supply line will read 18A.

Q31. Answer: A

Wound rotor motors have accessible rotor windings brought out through slip rings, allowing external resistance to be added. This reduces starting current while maintaining high starting torque, and provides limited speed control — its advantage over the squirrel-cage type.

Q32. Answer: B

CSA Z462 defines the limited approach boundary for systems up to 600V as 1.05 m (3.5 ft) — only qualified workers may cross this boundary and must use appropriate PPE.

Q33. Answer: D

Safety relays/PLCs (certified to IEC 62061, ISO 13849) monitor safety functions such as E-stops, light curtains, and guard interlocks using redundant, self-diagnostic circuits. On fault detection, they cut power to hazardous functions so the machine reaches a safe state before harm occurs.

Q34. Answer: D

Three-phase real power: $P = \sqrt{3} \times V_L \times I_L \times \cos\theta$. Where V_L = line-to-line voltage, I_L = line current, $\cos\theta$ = power factor. This applies to balanced 3-phase systems.

Q35. Answer: D

4–20 mA current loop signals are the standard for transmitting process variables (temperature, pressure, flow) in industrial analog systems. 4 mA = 0% of range (allows cable break detection — 0 mA = fault). 20 mA = 100% of range. Current is noise-immune over long cable runs.

Q36. Answer: A

A soft starter uses SCRs (thyristors) to gradually ramp up voltage to the motor during starting, limiting inrush current and mechanical stress (belt, coupling, gearbox) compared to DOL starting.

Q37. Answer: B

Equipotential bonding mats ensure that the floor, equipment, and person are at the same electrical potential, preventing dangerous current flow through the worker during a ground fault. They are commonly used on metal grating and in substations, where step and touch potential hazards are greatest.

Q38. Answer: D

When a VFD decelerates a motor, the motor regenerates energy back to the VFD's DC bus. If that energy cannot be returned to the grid and the bus voltage rises above the limit, the dynamic braking module switches in a resistor to dissipate the excess energy as heat.

Q39. Answer: A

Service factor (typically 1.0–1.25) is the multiplier indicating how much above nameplate load the motor can safely operate continuously without damaging its insulation. A 10 HP motor with SF 1.15 can run at 11.5 HP continuously.

Q40. Answer: C

A 2-wire (loop-powered) transmitter draws its operating power from the 4–20 mA loop current. A 4-wire transmitter has a separate power supply (120V AC or 24V DC) and outputs a 4–20 mA signal independently.

Q41. Answer: A

Inductive loads (motors, transformers) draw reactive power (kVAR) from the utility. Capacitor banks supply this reactive power locally, reducing the reactive current drawn through supply cables, improving power factor, and reducing utility demand charges and penalties.

Q42. Answer: C

Motor branch-circuit overcurrent protection is covered by CEC Section 28 (Rule 28-200), not Section 26. Because motor starting current can reach 6–8× FLC, the branch-circuit device is sized above FLC using the Code multipliers so it can ride through the starting inrush. The separate running overload protection (set at 115–125% of FLC per Rule 28-306, depending on service factor) is what protects the motor from sustained overcurrent.

Q43. Answer: D

Y-Δ starting connects windings in star (Y) first, applying 1/√3 of line voltage per winding, reducing starting current and torque to 1/3 of DOL values. After acceleration, the starter switches to delta (Δ) for full power.

Q44. Answer: D

The motor nameplate provides rated electrical, mechanical, and thermal data: voltage, phase, frequency, FLA, HP/kW, RPM, duty cycle, insulation class, service factor, efficiency, enclosure type, and NEMA/IEC frame designation — all critical for proper motor selection, installation, and protection.

Q45. Answer: A

4mA is the minimum live-zero standard — 3.6mA indicates a transmitter fault or calibration drift. In a 4-20mA system, 4mA = 0% process. Below 4mA is outside the valid range and indicates transmitter fault, severely low loop supply voltage (< 12V at transmitter), or calibration drift. Check supply voltage first (should be 24VDC minus line drops), then check zero trim and recalibrate or replace the transmitter.

Q46. Answer: C

CEC recommends maximum 3% voltage drop on branch circuits and 5% total (feeder + branch). At 6.7% drop, the conductor is undersized for the run. Voltage drop = I × R; reduce R by increasing conductor cross-section. Use the voltage drop formula to select the correct conductor: larger AWG = lower resistance = less voltage drop.

Q47. Answer: B

In ladder logic, a NO contact (XIC instruction in Allen-Bradley) allows rung continuity when the corresponding bit in memory is 1 (TRUE). It represents the state when the associated coil or input is energized.

Q48. Answer: B

CEC Section 2 (General Rules) contains foundational requirements — definitions, approval of equipment and materials, marking and identification, and administrative rules — that apply to all other sections of the code unless specifically modified. Wrong answers confuse it with: Section 10 (Grounding and bonding), Section 12 (Wiring methods), or Section 26 (Installation of electrical equipment). Section 2 is important for industrial electricians because it defines 'approved' equipment (CSA/UL listed or acceptable equivalent), sets the authority having jurisdiction (AHJ) as the final arbiter, and establishes that the CEC is a minimum standard — AHJ can and often does add local requirements. On Red Seal exams, Section 2 questions often test whether candidates know what 'approved' means (certified by an accredited testing organization, not just brand-name).

Q49. Answer: D

HART (Highway Addressable Remote Transducer) superimposes a digital FSK signal (±0.5 mA at 1200/2200 Hz) on top of the 4–20 mA loop. Its primary advantage: digital configuration, diagnostics, and second variable access without disrupting the analog 4–20 mA control signal.