

# Industrial Electrician Level 4

## Industrial Electrician

**Unit:** D1 Industrial Electrical Code II

**Level:** Four

**Duration:** 42 hours

Theory: 42 hours

Practical: 0 hours

### Overview:

This unit, which builds on *C1 Industrial Electrical Code I*, is designed to provide the apprentice with additional knowledge about the industrial electrical code. The unit begins with coverage of industrial wiring methods and calculations for industrial electric equipment. Part of the unit covers shock, flash and blast protection for industrial applications. Finally, the unit covers renewable energy system installations.

Objectives and Content:	Percent of Unit Mark (%)
1. Review hazards and safe work practices pertaining to industrial electrical code applications.	5%
2. Describe industrial wiring methods and practices. <ul style="list-style-type: none"><li>a. CEC requirements</li><li>b. Bonding and grounding of electrical and non-electrical equipment</li><li>c. Considerations in hazardous locations</li><li>d. Cathodic protection</li><li>e. Seismic restraint systems</li><li>f. High voltage splicing methods</li><li>g. Emergency stand-by systems<ul style="list-style-type: none"><li>• Manual transfer switches</li><li>• Automatic transfer switches</li></ul></li></ul>	30%
3. Perform calculations for industrial electric equipment. <ul style="list-style-type: none"><li>a. CEC requirements</li><li>b. Minimum conductor ampacities<ul style="list-style-type: none"><li>• Motors</li><li>• Transformers</li><li>• Welders</li><li>• Capacitors</li><li>• Lighting systems</li><li>• Electric heating.</li></ul></li><li>c. Minimum overcurrent protection<ul style="list-style-type: none"><li>• Motors</li><li>• Transformers</li></ul></li></ul>	35%

- Welders
- Capacitors
- Lighting systems
- Electric heating
- d. Minimum overload protection
  - Motors

**4. Describe shock, flash and blast protection for industrial applications. 15%**

- a. The Workplace Safety and Health Act
- b. Purpose
- c. Conditions for use

**5. Describe renewable energy system installations. 15%**

- a. CEC requirements
- b. Fuel cells
- c. Wind (turbines)
- d. Solar (photovoltaic cells)
- e. Tidal

\*\*\*

## Industrial Electrician

**Unit:** D2 Industrial Control Systems II

**Level:** Four

**Duration:** 77 hours

Theory: 35 hours

Practical: 42 hours

### Overview:

This unit, which builds on *C5 Industrial Control Systems I*, is designed to provide the apprentice with additional knowledge about industrial control systems. The unit begins with advanced operation of programmable logic controller and programming of advanced ladder logic. Part of the unit covers analog inputs/outputs and control system diagrams. Finally, the unit covers installing, troubleshooting and commissioning of building automation systems and process control.

Objectives and Content:	Percent of Unit Mark (%)
1. Review hazards and safe work practices pertaining to industrial control systems.	5%
2. Describe and demonstrate advanced operation of programmable logic controllers (PLCs).	15%
<ul style="list-style-type: none"> <li>a. Purpose</li> <li>b. Types               <ul style="list-style-type: none"> <li>• Fixed</li> <li>• Modular</li> <li>• Remote</li> </ul> </li> <li>c. Components               <ul style="list-style-type: none"> <li>• Central processing unit (CPU)</li> <li>• Memory storage systems</li> <li>• Input/output (I/O) section</li> <li>• Power supply</li> <li>• Programming devices</li> </ul> </li> <li>d. Advanced operation and applications               <ul style="list-style-type: none"> <li>• Distributed control systems (discrete, analog, PI and PID networks)</li> <li>• Open/Closed loop control systems</li> <li>• Computer Numerically Controlled (CNC) machines</li> <li>• Instrumentation devices</li> </ul> </li> </ul>	
3. Describe and demonstrate programming of advanced ladder logic.	15%
<ul style="list-style-type: none"> <li>a. Purpose</li> <li>b. Types               <ul style="list-style-type: none"> <li>• Discrete I/O</li> </ul> </li> </ul>	

- Analog I/O
  - Remote I/O
  - Specialty modules
  - c. Configurations
    - Local (fixed and modular I/O's)
    - Remote (distributed I/O and Distributed Control Systems (DCS))
  - d. Programming and wiring considerations
    - Memory limitations
    - Networks
    - Program Scan
    - Contact Nesting
    - Security (key lock and software)
    - Master control relay
    - Stop and emergency stop push buttons
    - Program documentation
- 4. Define and describe analog I/O's, their applications and external components. 15%**
- a. Purpose
  - b. Components
    - Transducers
    - Transmitters
    - Voltage sensing modules
    - Current sensing modules
  - c. Applications
    - Resolution/Scaling
    - Binary conversion
  - d. Wiring methods
  - e. Perform related calculations
    - Binary
    - Binary- coded decimal (BCD)
    - Octal
    - Hexadecimal
- 5. Create, interpret and demonstrate advanced applications of industrial control system diagrams. 15%**
- a. Programming relay type instructions
    - System configurations
    - Address locations (internal and external)
    - Documentation methods
  - b. Programming discrete inputs
    - Examine on and examine off
    - Transitional contacts
  - c. Programming outputs
    - Discrete
    - Logical/internal
    - Latching relay instructions
    - Interposing relays
    - Sourcing and Sinking
  - d. Timers
    - Address locations

- Preset and accumulated times
  - Time on and time off
  - Cascading
  - e. Counters
    - Address locations
    - Preset and accumulated count
    - Count up and count down
- 6. Demonstrate and perform troubleshooting methods. 10%**
- a. Purpose
  - b. Key considerations
    - Bonding connections
    - Low and extra low voltage systems
    - Controller (including self diagnostics)
    - LED indicators
    - Watch dog timer
    - Power supplies
    - I/O modules (discrete, analog and specialty)
    - Overcurrent protection
    - Search functions
    - Force/Disable functions
    - External inputs and outputs
    - Internal relays/contacts
- 7. Describe instrumentation devices and common applications. 5%**
- a. Variables measured
    - Thermal
    - Weight
    - Pressure
    - Volume
    - Flow
    - Level
  - b. Calibration methods
    - Span
    - Resolution
    - Transducers
    - Transmitters
- 8. Describe and apply installation and operation of building automation systems. 10%**
- a. Energy management systems
  - b. Annunciation systems
  - c. HVAC systems and environmental controls
  - d. Fire alarm systems
  - e. Microprocessor-based lighting controls
  - f. Devices, wiring methods and addressable systems
- 9. Describe and apply installation of process control. 5%**
- a. Purpose and application
  - b. Perform related calculations

**10. Describe and demonstrate motor control networking (MCC).**

**5%**

- a. Networking fundamentals
- b. Intelligent MCC

\*\*\*

## Industrial Electrician

**Unit:** D3 Electronic Concepts III

**Level:** Four

**Duration:** 49 hours

Theory: 28 hours

Practical: 21 hours

### Overview:

This unit, which builds on *B5 Electronic Concepts I* and *C4 Electronic Concepts II*, is designed to provide the apprentice with additional knowledge about electronic concepts. This unit covers electronic concepts for rectifier circuits, converter circuits, inverter circuits, transducers and transmitters, and operational amplifiers.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Review hazards and safe work practices pertaining to electronic concepts.	5%
2. Describe rectifier circuits. <ul style="list-style-type: none"> <li>a. Purpose and applications</li> <li>b. Types               <ul style="list-style-type: none"> <li>• Single-phase</li> <li>• Three-phase</li> </ul> </li> <li>c. Perform related calculations for a half wave, full wave and bridge rectifier               <ul style="list-style-type: none"> <li>• Peak</li> <li>• Root mean squared (RMS)</li> <li>• Average current</li> <li>• Average voltage</li> </ul> </li> <li>d. Operating considerations of a capacitor, inductor and resistor in a rectifier filter circuit               <ul style="list-style-type: none"> <li>• Percent ripple</li> <li>• Voltage and current regulation</li> </ul> </li> </ul>	20%
3. Describe converter circuits. <ul style="list-style-type: none"> <li>a. Purpose and applications</li> <li>b. Perform related calculations</li> </ul>	10%
4. Describe inverter circuits. <ul style="list-style-type: none"> <li>a. Purpose and applications</li> <li>b. Perform related calculations</li> </ul>	10%
5. Describe transducers and transmitters. <ul style="list-style-type: none"> <li>a. Purpose and applications</li> <li>b. Types</li> </ul>	20%



- 4-20 mA
  - 0-10 V DC
  - c. Perform related calculations
    - Scaling
    - Calibration
- 6. Describe operational amplifiers. 15%**
- a. Purpose and applications
  - b. Types
    - Proportional
    - Integral
    - Derivative
  - c. Operating characteristics
  - d. Perform related calculations
- 7. Demonstrate and apply electronic concepts for rectifier circuits, converter circuits, inverter circuits, transducers and transmitters, and operational amplifiers. 20%**
- a. Rectifier circuits
    - Interpret circuit diagrams and construct rectifier circuits
    - Identification of output signals with oscilloscope
    - Calculate the output frequency
  - b. Converter circuits
  - c. Inverter circuits
  - d. Transducers and transmitters
    - Gain and span
  - e. Operational amplifiers

\*\*\*

## Industrial Electrician

**Unit:** D4 AC and DC Variable Speed Motor Drives

**Level:** Four

**Duration:** 49 hours

Theory: 28 hours

Practical: 21 hours

### Overview:

This unit is designed to provide the apprentice with the knowledge about AC and DC variable speed motor drives. This unit covers electronic soft starters and AC and DC variable speed drives.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
<b>1. Identify hazards and describe safe work practices pertaining to AC and DC variable speed motor drives.</b>	<b>5%</b>
<b>2. Describe electronic soft starters.</b>	<b>35%</b>
a. Purpose and application	
• Key considerations	
b. Components	
• Theory	
c. Operating characteristics	
d. Perform related calculations	
• Ratings (wiring methods based on CEC requirements)	
<b>3. Describe and demonstrate installation of AC variable speed drives.</b>	<b>35%</b>
a. Purpose and applications	
b. Components	
• Theory	
c. Operating characteristics	
d. Perform related calculations	
• Ratings (wiring methods based on CEC requirements)	
e. Installation and operation	
<b>4. Describe and demonstrate installation of DC variable speed drives.</b>	<b>25%</b>
a. Purpose and applications	
b. Components	
• Theory	
c. Operating characteristics	

- d. Perform related calculations
  - Ratings (wiring methods based on CEC requirements)
- e. Installation and operation

\*\*\*

## Industrial Electrician

**Unit: D5 Predictive and Preventive Maintenance II**

**Level:** Four

**Duration:** 42 hours

Theory: 35 hours

Practical: 7 hours

### Overview:

This unit, which builds on *C7 Predictive and Preventive Maintenance I*, is designed to provide the apprentice with additional knowledge about predictive and preventive maintenance. This unit covers safety requirements, insulation testing and maintenance practices. This unit also covers maintenance, repairs and operation of electrical equipment.

Objectives and Content:	<b>Percent of Unit Mark (%)</b>
1. Review hazards and safe work practices pertaining to predictive and preventive maintenance.	5%
2. Describe safety requirements for predictive and preventive maintenance. a. Personal protective equipment (PPE) b. Lock-out and tag-out procedures c. Equipment and personal grounding	15%
3. Describe insulation testing. a. Types • Sixty second test • Step voltage test • Dielectric absorption test • Polarization Indexing b. Procedures and application • Test equipment c. Tests requirements • Motors • Welder • Capacitors • Transformers • Lighting systems • Electric heating	25%
4. Describe and perform maintenance, repairs and operation of electrical equipment. a. Types • Batteries	30%

- Motor Control System Components
  - High and Low Voltage Distribution
  - Generating Equipment
  - Motors
  - Generators
  - Transformers
  - Capacitors
  - Over-current protection (OCP)
  - Overload protection (OLP)
  - Ground fault protection devices
  - Metering
  - Drives
  - UPS's
- b. Procedures

**5. Describe predictive maintenance practices.**

**25%**

- a. Advanced Maintenance Technologies
- Infrared Scanning
  - Vibration Analysis
  - Ultrasonic Analysis
  - Harmonic Analyzers
  - Computerized Maintenance Management Systems (CMMS)

\*\*\*

## Industrial Electrician

**Unit:** D6 Hydraulic and Pneumatic Power Control Systems

**Level:** Four

**Duration:** 7 hours

Theory: 3 hours

Practical: 4 hours

### Overview:

This unit is designed to provide the apprentice with the knowledge about hydraulic and pneumatic power control systems. This unit covers hydraulic and pneumatic devices, and the use and applications of hydraulic and pneumatic power control systems.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
<b>1. Identify hazards and describe safe work practices pertaining to hydraulic and pneumatic power control systems.</b>	<b>5%</b>
<b>2. Describe basic hydraulic and pneumatic devices.</b>	<b>45%</b>
a. Purpose and applications	
• Symbols and schematics	
b. Components	
c. Operating characteristics	
• Solenoid activated valves	
• Servo valves	
• Valve positioning	
<b>3. Demonstrate use and applications of hydraulic and pneumatic power control systems.</b>	<b>50%</b>
a. Interpret symbols and schematics	
b. Installation	

\*\*\*

## Industrial Electrician

**Unit:** D7 Electrical Measuring Systems

**Level:** Four

**Duration:** 35 hours

Theory: 17 hours

Practical: 18 hours

### Overview:

This unit is designed to provide the apprentice with the knowledge about electrical measuring systems. This unit covers the operation of protective relay systems, power measuring systems and synchronizing metering systems. This unit also covers the operation of speed, flow, pressure, heat and level electrical measuring systems.

Objectives and Content:	Percent of Unit Mark (%)
1. Identify hazards and describe safe work practices pertaining to electrical measuring systems.	5%
2. Describe and demonstrate operation of protective relay systems. a. Purpose and applications b. Types • Disc • Electronic c. Components d. Operation e. Installation considerations, including switching order f. Settings and adjustments g. Identification of protective relays	25%
3. Describe and demonstrate operation of power measuring systems. a. Purpose and applications b. Types • Current transformers • Potential transformers • Watt meters c. Components d. Operation e. Installation considerations	25%
4. Describe and demonstrate operation of synchronizing metering systems. a. Purpose and applications b. Types • Synchroscope	20%

- Indicating light method
- c. Components
- d. Operation
- e. Installation considerations

**5. Describe and demonstrate operation of speed, flow, pressure, heat and level electrical measuring systems. 25%**

- a. Purpose and applications
- b. Types
  - Speed
  - Flow and pressure
  - Heat
  - Level
  - Weight
- c. Components
  - Speed (including tachometer, encoder and resolver)
  - Flow and pressure (including orifice plate)
  - Heat (including thermal couple and resistive thermal device)
  - Level (including floats and inductive probes)
  - Weight
- d. Operation
- e. Instrument calibration methods
  - Span
  - Resolution

\*\*\*



## Industrial Electrician

**Unit:** D8 Journeyperson Trainer

**Level:** Four

**Duration:** 7 hours

Theory: 7 hours

Practical: 0 hours

### Overview:

Level One in-school technical training offers an entry-level orientation to the challenges of apprenticeship training as it relates to the development of core tasks and skill requirements, as well as social competencies. This unit introduces senior apprentices to the responsibilities of workplace training that they will assume as supervising journeypersons. Most trades have a rich tradition of refreshing and sharing their trade skills from one generation of trade practitioner to the next. This unit orients senior apprentices to some of the practical and conceptual tools that can enable them to contribute to this trade heritage when they become certified journeypersons and, ultimately, journeyperson trainers.

The journeyperson's obligation to assist entry-level apprentices to develop skills and knowledge is complex and challenging. It involves safety considerations, employer expectations, provincial regulations, as well as the tradition of skills stewardship that links modern practice with the long history of workplace teaching and learning that defines the apprenticeable trades. The ability to offer timely and appropriate support to apprentices is itself an important area of trade learning. This unit presents material intended to help refine this ability through reflection and discussion by senior apprentices, and discussion with their in-school instructor and journeyperson trainer.

This content reflects Manitoba and Canadian standards prescribed for journeyperson-level supervisory capabilities, as well as key topics in current research on the importance of workplace training in apprenticeship systems. These detailed descriptors represent suggested focal points or guidelines for potentially worthwhile exploration, and are neither mandatory nor exhaustive.

**Note: No percentage-weightings for test purposes are prescribed for this unit's objectives. Instead, a 'Pass/Fail' grade will be recorded for the unit in its entirety.**

Objectives and Content:	Percent of Unit Mark (%)
<ol style="list-style-type: none"> <li>1. <b>Compare/contrast role-options and responsibilities of the supervising journeyperson.</b> <ol style="list-style-type: none"> <li>a. Implicit vs. explicit standards and content: training goals are/are not codified; assessment measures are/are not used</li> <li>b. Accountability for results: e.g. journeyperson is/is not required to prepare performance evaluation that could affect apprentice's employability or wage-rate, etc.</li> <li>c. Long-term vs. short-term supervision assignments – e.g., considerable latitude/little latitude for apprentice to learn from mistakes</li> <li>d. Formally vs. informally structured – e.g. supervision assignment is part of a prescribed cycle of assignments involving coordination among multiple journeypersons; apprentice is trained according to an individual training plan negotiated with employer</li> </ol> </li> </ol>	n/a

- e. Types of supervisory role options and what is implied by each:
  - Journeyperson Trainer (JT) role: often initiated by someone other than apprentice, and limited to a particular skill set, task, or production requirement
  - Mentor role: often initiated by apprentice, and relatively open-ended regarding content, duration, etc.
  - Peer role: typically involves individual upgrading or cross-training of one journeyperson by another; can include senior apprentice assisting less-experienced trade learner
  - Coordinator role: often a senior-level journeyperson appointed by an organization to assume responsibilities for monitoring progression of groups of apprentices
  - Other roles: may be improvised by journeyperson, such as combination or multiple roles of the above

**2. Describe and demonstrate common requirements about providing journeyperson level supervision. n/a**

- a. Apprenticeship learning adapted to journeyperson supervision assignments and a journeyperson perspective
  - Application of adult education concepts to trades teaching and learning (e.g. responsibilities and expectations of senior-level apprentices)
  - Practical significance of 'styles' of adult learning and teaching
  - Helping senior-level apprentices integrate in-school technical training and on-the-job practical training experiences
  - Providing help and guidance about new tasks and skills
  - Providing help and guidance about fixing mistakes
  - Learning and teaching "the ropes" – socialization of apprentice within a community of trade practice (e.g. how to borrow a tool, interrupt a journeyperson, seek advice of experienced co-workers)
  - Coverage and documentation of prescribed tasks and subtasks where applicable.
  - Discuss the limits of the journeyperson trainers' own responsibilities and competence (e.g. scope, willingness to train, etc.)
  - Benefits of maintaining a personal record of achievements, ideas, and needs as a journeyperson trainer (e.g. resume, portfolio, training credentials, logbook, etc.)
- b. Individual reflection and guided group discussion about personal experiences of workplace learning as an apprentice
  - Identification of best and worst practices of journeyperson trainer
  - Identification of workplace and other factors that can contribute to good and bad trades teaching/learning experiences
  - Development of professional standards and work ethics about responsibility to share one's knowledge and skill with others in the workplace (e.g., use/misuse of humour, rigour, discretion, craft-pride, etc.)
  - Qualities of a good journeyperson trainer
  - Components of workplace journeyperson training
  - Processes and recommended practices re: journeyperson training
  - Troubleshooting problems re: supervision assignments
- c. Role of assessment in supervising, coaching, or guiding other people to learn or improve their skills (e.g. formative and summative evaluation), and how this might contribute to how the journeyperson-level supervision task is approached in future
- d. Compare and contrast discussion results with current knowledge and resources about workplace training methods as they apply to journeyperson-level supervision assignments
- e. Other (as may be specified by instructor)

\*\*\*

## Industrial Electrician

**Unit:** D9 Pre-Interprovincial Exam Review

**Level:** Four

**Duration:** 42 hours

Theory: 42 hours

Practical: 0 hours

### Overview:

This unit offers senior apprentices a systematic review of skills and knowledge required to pass the Inter-Provincial Examination. It promotes a purposeful personal synthesis between on-the-job learning and the content of in-school technical training. The unit includes information about the significance of Interprovincial certification and the features of the Interprovincial Examination.

**Note:** No percentage-weightings for test purposes are prescribed for this unit's objectives. Instead, a 'Pass/Fail' grade will be recorded for the unit in its entirety.

Objectives and Content:	Percent of Unit Mark (%)
<p><b>1. Describe the significance, format and general content of Inter-Provincial (IP) Examinations for the trade of Industrial Electrician.</b></p> <ul style="list-style-type: none"> <li>a. Scope and aims of Inter-Provincial certification; value of certifications</li> <li>b. Obligations of candidates for Inter-Provincial certification               <ul style="list-style-type: none"> <li>• Relevance of Inter-Provincial Examinations to current, accepted trade practices; industry-based provincial and national validation of test items</li> <li>• Supplemental Policy (retesting)</li> <li>• Confidentiality of examination content</li> </ul> </li> <li>c. Multiple-choice format (four-option) item format, Red Seal standards for acceptable test items</li> <li>d. Government materials relevant to the Inter-Provincial Examinations for apprentice Industrial Electricians               <ul style="list-style-type: none"> <li>• Red Seal Occupational Standard (RSOS) for Industrial Electrician; prescribed scope of the skills and knowledge which comprise the trade</li> <li>• RSOS "Pie-chart" and its relationship to content distribution of Inter-Provincial Examination items</li> <li>• Apprenticeship Manitoba Technical Training package</li> </ul> </li> </ul>	n/a
<p><b>2. Identify resources, strategies and other considerations for maximizing successful completion of written examinations.</b></p> <ul style="list-style-type: none"> <li>a. Personal preparedness               <ul style="list-style-type: none"> <li>• Rest</li> <li>• Nutrition</li> <li>• Personal study regimen</li> <li>• Prior experience in test situations (e.g., Unit Tests)</li> </ul> </li> </ul>	n/a

- b. Self-assessment, consultation and personal study plan
    - Self-assessment of individual strengths/weaknesses in trade related skills and knowledge
    - Approved textbooks
    - Study groups
- |    |   |            |
|----|---|------------|
| 3. | <b>Review program content regarding the major work activity of performs common occupational skills.</b>   | <b>n/a</b> |
| 4. | <b>Review program content regarding the major work activity of installs and maintains generating, transmission, distribution and service systems.</b> | <b>n/a</b> |
| 5. | <b>Review program content regarding the major work activity of installs and maintains wiring systems.</b>   | <b>n/a</b> |
| 6. | <b>Review program content regarding the major work activity of installs and maintains rotating and other fixed equipment and control systems.</b>     | <b>n/a</b> |
| 7. | <b>Review program content regarding the major work activity of installs and maintains signalling and communication systems.</b>                       | <b>n/a</b> |
| 8. | <b>Review program content regarding the major work activity of installs and maintains process control systems.</b>                                    | <b>n/a</b> |

\*\*\*