

Power Electrician Level 1

Power Electrician

Unit: A1 Electrical Code I

Level: One

Duration: 130 hours

Theory: 90 hours

Practical: 40 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with the basic knowledge and understanding of residential wiring and load calculation. Hence, the apprentice should have a good basic knowledge of a residential occupancy in regard to electrical wiring and all electrical wiring shall be done to conform to the Canadian Electrical Code, Part I, Manitoba Hydro amendments and City of Winnipeg by-laws.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe the code book in terms of:	30%
a. Layout, Contents, Index, Appendices, Conversions, trade terminology, blueprints	
b. AC low voltage and extra low voltage systems	
c. Conductors and cables: temp ratings, ampacities and sizing, conditions of use of types of conductors and cables	
d. Sizes and types of outlet boxes	
e. Selection of, the placement of and circuiting of receptacles in general	
f. The purpose of and sizing of bonding conductors	
g. Advantages of 3 wire over 2-2 wire circuits	
h. Types of and ratings of overload protection and overcurrent protection	
i. Potential circuit problems	
j. General use switches	
k. General types and usages of lighting	
l. Various types of raceways	
m. Blueprint reading and job specifications	
n. Installation of special purpose outlets	
o. Various types of heating and heating control requirements.	
p. Temporary wiring requirements	
r. Overhead and underground service installations	
s. Purpose of and sizing of grounding conductors	
2. Describe how to perform raceway fill calculations.	7%
a. Different types of conductors.	
b. Different sizes of conductors.	

- | | |
|--|------------|
| 3. Describe how to perform box fill calculations. | 7% |
| 4. Describe how to perform branch circuit calculations: | 16% |
| <ul style="list-style-type: none"> a. Range b. Dryer c. Hot water tank d. Electric space heat e. Single phase motor f. Special purpose outlets g. Convenience outlets (lights, receptacles). h. Voltage drop calculations. | |
| 5. Describe how to perform service calculations for single phase 3 wire,120/240V: | 7% |
| <ul style="list-style-type: none"> a. O.C.P b. Wire size and type c. Raceway size and type d. Bonding Jumper size e. Grounding. | |
| 6. Describe voice data video (VDV) structured cabling (copper) installation requirements and procedures. | 2% |
| 7. Draw, wire and terminate branch circuit devices. | 21% |
| 8. Install, test and troubleshoot VDV structured cabling (copper) components and devices. | 7% |
| 9. Describe types of fasteners, grades of bolts and torque specifications | 1% |
| 10 Select correct fasteners, grades of bolts and apply correct torque values. | 1% |
| 11 Describe compatibility of materials. | 1% |
| <ul style="list-style-type: none"> a. Metals | |

Power Electrician

Unit: A2 DC and Electrical Fundamentals

Level: One

Duration: 120 hours

Theory: 120 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with the basic knowledge and understanding of DC and Electrical fundamentals.

With few exceptions, this is a highly analytic (problem solving) Unit. In general, the descriptive material constitutes a minor portion of the course – the major part of it is problem solving and analysis.

Objectives and Content:	Percent of Unit Mark (%)
1. Describe Energy, Power and Ohm's Law with a focus on:	24%
a. Explaining the SI system of units and its use in electrical measurement	
b. Explaining (and computing) how to convert between units	
c. Explaining (and computing) how Powers of ten are used to represent very large and very small numbers	
d. Explaining (and computing) using Engineering units employing the system of common Engineering prefixes such as milli, micro, kilo	
e. Explaining how circuits are represented by various types of diagrams, including block, pictorial and schematic	
f. Explaining the basic structure of the atom, with special emphasis on the concept of electrical charge and free electrons	
g. Explaining what constitutes a conductor and what constitutes an insulator	
h. Explaining and computing the charge in coulombs	
i. Explaining what is meant by voltage and potential difference	
j. Explaining and computing current from charge flow	
k. Explaining conventional and electron current flow.	
l. Explaining some practical DC voltage sources (e.g., batteries)	
m. Describe different kinds and sizes of batteries, including their characteristics, amp hour ratings and limitations.	
• Lead acid	
• Nickel cadmium	
• Nickel iron	
• Other	
n. Describe battery storage and connection requirements.	
o. Describe battery-related safety hazards such as chemicals, and the precautions required in working with batteries.	

- Insulated/nonsparking tools
 - Aprons
 - Face shields
 - Gloves
 - Other
- p. Describe measuring charger circuit-current and voltage-wave patterns.
- q. Describe battery/bank installations regarding varying loads and conditions.
- r. Describe battery bank paralleling procedures.
- s. Describe float levels, and equalize levels.
- t. Describe battery charger systems testing methods.
- u. Explaining basic voltage and current measurement using voltmeters and ammeters
- v. Explaining the nature of resistance and the factors that contribute to it.
- w. Computing the resistance of wires and bus bars using metric units and AWG Tables (wires) only
- x. Computing the temperature effect on resistance
- y. Explaining various types of standard resistors, including Power ratings and colour coding
- z. Explaining the meaning of conductance.
- aa Computing voltage and current in a resistance using Ohm's law
- bb Explaining voltage polarity and current direction.
- cc Computing how Power is related to voltage, current and resistance
- dd Explaining Power in a DC circuit
- ee Computing energy in kwh and in joules
- ff Computing efficiency for some simple systems.

2. Describe Series and Parallel DC Circuits with a focus on: 19%

- a. What is meant by a series circuit.
- b. Computing the total resistance of a series circuit
- c. Computing voltages in a series circuit using Kirchhoff's voltage law (KVL)
- d. Computing current and Power in a series circuit
- e. Computing voltage sources in series
- f. Computing voltages using the voltage divider rule (VDR)
- g. The concept of circuit grounds
- h. What is meant by a parallel circuit
- i. Computing the total resistance of a parallel circuit
- j. Computing currents in a parallel circuit
- k. Computing current using Kirchhoff's current law (KCL)
- l. Computing Power in a parallel circuit
- m. Computing currents using the current divider rule (CDR).

3. Describe Series-Parallel DC Circuits with a focus on: 19%

- a. What is meant by a series-parallel circuit
- b. Computing the total resistance of a series-parallel circuit
- c. Computing voltages, currents and Power in a series-parallel circuit by applying Ohm's law, KVL, KCL, VDR and CDR as applicable
- d. Computing circuit variables when sources are represented in point source form
- e. Computing voltage between any two points in a circuit.

4. Describe Magnetism applications with a focus on: 14%

- a. The nature of magnetic fields, including the concept of flux, force fields, the

- Field around current carrying conductors
- b. How magnetic flux, flux density, magnetomotive force and reluctance are related
 - c. Showing how to calculate the current required to establish a required magnetic Flux in a series magnetic circuit
 - d. The operation of a relay as a magnetic circuit
 - e. Showing (e.g., ampere turns) the forces created by magnetic attraction in relays and solenoids.
- 5. Describe D.C. Instruments (including the operation of direct current measuring instruments, their Power and use). 8%**
- a. Analog meter movement
 - b. Voltmeter circuit
 - c. Ammeter circuit
 - d. Wattmeters
- 6. Describe electromagnetism and Inductance (including the operation of coils). 8%**
- a. Rotating magnetic fields
 - b. Generator applications
 - c. Stored energy (Lenz's Law)
 - d. Motor principles.
- 7. Describe electrical fundamentals with a focus on: 8%**
- a. Defining, explaining, listing, calculating or demonstrating
 - The difference between DC and AC
 - Why DC is preferred in some Power applications to AC
 - What advantages AC has over DC in the generation, transmission and distribution systems and why it has these advantages
 - Why high voltage DC has been used for transmission of energy from distant generating stations
 - The graphic method of generating sine waves and cosine waves and will be able to relate these to the trigonometric formula
 - How a sinusoidal voltage is generated when a coil is rotated in a uniform magnetic field
 - What factors determine the frequency of the voltage from an AC generator
 - Instantaneous and Peak Values.
 - b. Explaining, computing, describing, plotting, defining or comparing resistive circuits and rectification
 - The phase relationship between voltage and current in an AC circuit containing a resistance
 - The effective values of AC current and voltages
 - The Power dissipated in a resistor for a given applied peak voltage
 - The difference between the voltage given by an AC voltmeter and that displayed on an oscilloscope
 - A Power curve, the current and voltage in phase
 - The action of a half and full wave rectifier and why average values instead of effective values are used for computing the DC output
 - c. Single-phase transformers
 - Describe the Power of a simple transformer by naming its parts and showing the interrelationships which exist
 - d. Solve problems for an ideal transformer involving: current ratios, voltage ratios, Power transfer, turns ratios.

Power Electrician

Unit: A3 Mathematics and Sciences

Level: One

Duration: 60 hours

Theory: 60 hours

Practical: 0 hours

Overview:

This unit of instruction is primarily designed to provide the Electrician apprentice with the knowledge and understanding of mathematical operations for technical problem solving. This unit of instruction is also designed to provide the Electrician apprentice with the knowledge and understanding of scientific principles to the solution of technical problems. The latter provides some of the scientific facts and concepts, which are the basis for the subject of Electricity. Topics include the metric system, space/time relationships, force, work, energy, Power and light. On completion of the course, the apprentice will be able to solve velocity and acceleration problems; solve force, work, energy, and Power problems; describe light and its sources.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe and solve problems using algebraic equations, and formulas:	13%
a. Algebraic equations (addition, subtraction, multiplication and division)	
b. Transposing of algebraic equations	
c. Fractions (addition, subtraction, multiplication and division), decimals and percent	
d. Positive and negative numbers.	
2. Describe and solve ratio and proportion problems:	6%
a. Efficiency	
3. Describe how to solve areas and volumes in electrical calculations:	10%
a. Circular mils, square mils, mm ²	
b. Length of wire (voltage drop)	
c. Resistance of wire	
4. Describe and solve the rules of significant figures and engineering notation:	10%
a. Powers of 10	
b. Engineering terminology (kilo, Mega, micro, milli, etc.)	
c. Usage of significant figures.	
5. Describe and solve basic Ohm's Law and series circuits:	5%
a. Resistance calculations (total and component)	
b. Voltage drop calculations (total and component)	
c. Current calculations (total and component)	

- d. Power calculations (total and component)
- 6. Describe and solve parallel circuit rules: 3%**
- Resistance calculations (total and component)
 - Voltage drop calculations (total and component)
 - Current calculations (total and component)
 - Power calculations (total and component).
- 7. Describe and demonstrate how to plot data on graphs: 3%**
- Display abscissa and ordinate (horizontal and vertical line)
 - Display proper scaling, and base line or reference line.
- 8. Describe and solving basic right angle triangle and trigonometry problems using: 17%**
- Pythagorean Theorem
 - Sine function
 - Cosine function
 - Tangent function
 - Complex numbers.
- 9. Describe simple machines, force, and pressure. 9%**
- Identify simple machines (level, inclined plane, screw, pulley, and hydraulic press) which make up more complex machines and common tools.
 - Solve force-distance problems involving simple machines.
 - Calculate theoretical and actual mechanical advantages of various machines.
 - Solve problems involving static or sliding friction.
 - Solve problems involving pressure, force and Power.
- 10. Describe units of measure, in the SI and Imperial systems. 3%**
- 11. Describe how to use systems of measurement in the SI and Imperial systems and apply unit-conversion factors. 3%**
- 12. Describe scientific principles, especially as applied to cells, batteries, and chemical reaction. 3%**
- 13. Describe requirements for carrying out standard scientific procedures, including scientific method in relation to such tasks as monitoring, measurement, and data collection/analysis. 3%**
- Inductive/deductive reasoning
 - Control of variables
 - Verifiability of results
- 14. Solve technical problems by applying basic scientific knowledge and scientific method. 3%**
- 15. Describe work, Power, energy and torque in relation to distance, force, time and efficiency. 3%**
- 16. Describe gas laws. 3%**
- Pressure
 - Temperature
 - Volumes and vacuum

17. Describe the nature of light, and the frequencies of light.

3%

- a. The basics behind incandescent lighting
- b. The basics behind fluorescent lighting
- c. The basics behind high intensity discharge lighting
- d. The units candela, lumen and lux, and how these are measured.
- e. Light efficiency in terms of lumens per watt, and which sources of light can be considered most efficient.

Power Electrician

Unit: A4 Computers

Level: One

Duration: 15 hours

Theory: 5 hours

Practical: 10 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with the basic knowledge and understanding of computers. Provincial Advisory Committee members feel that being able to access electronic resources is a vital part of your trade education.

After completing this unit, apprentices will be able to learn, amongst other skills, to load software, input, save and print data, and shut down the operating system. Beyond the obvious benefits of the computer for word processing and organizational tasks, all apprentices will also be able to recognize and use the search operating engine features on the Internet, and read and send e-mail messages.

It is strongly recommended that ALL apprentices be urged to formulate, and submit to their instructor for review, a personal study plan. Such a plan most usefully might timetable a course of action for reviewing all relevant material(s) and for strengthening self-assessed areas of deficient skills/knowledge.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe basic computer technology and its broad applications in the electrician's trade.	5%
2. Describe basic computer technology in its specific applications to one's everyday duties as a electrician.	5%
3. Describe basic computer technology in its specific applications to one's everyday duties as a electrician. <ul style="list-style-type: none">• DOS• Windows• NT• Others	5%
4. Describe requirements for loading software and for file management.	4%
5. Describe internet access software.	4%
6. Describe requirements for troubleshooting communication problems from a hardware and software perspective, with regard to proper cabling (modem/null modem), bit parity, and BAUD rates, and so on.	6%

- | | |
|---|------------|
| 7. Use operating systems for computer file management. | 14% |
| 8. Set up/configure computer environments. | 14% |
| • DOS | |
| • Windows | |
| • NT | |
| • Other | |
| 9. Use various computer operating systems. | 13% |
| • DOS | |
| • Windows | |
| • NT | |
| • Other | |
| 10. Load software and use proper file management techniques. | 13% |
| 11. Use internet access software. | 13% |

Power Electrician

Unit: A5 Communications with Co-workers and Others

Level: One

Duration: 15 hours

Theory: 5 hours

Practical: 10 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with the basic knowledge and understanding of communications with co-workers and others. Provincial Advisory Committee members feel that the informed use of basic communication and listening skills is a vital part of your trade education. After completing this unit, apprentices will be able to learn, amongst other skills, to recognize and differentiate between PERT and Gantt charts, interpret charts for the purposes of communicating with others, and communicating planning and scheduling activities. In addition to acquiring basic presentation and listening skills, apprentice-learners will perform such basic employability skills as organizing letters, writing letters, job resumes, and cover letters.

It is strongly recommended that ALL apprentices be urged to formulate, and submit to their instructor for review, a personal study plan. Such a plan most usefully might timetable a course of action for reviewing all relevant material(s) and for strengthening self-assessed areas of deficient skills/knowledge.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe effective communication and listening skills.	33%
a. Describe work flow procedure and practices (e.g., PERT and Gantt).	
b. Describe skills in giving, taking, and relaying instructions.	
c. Describe appropriate rules of conduct during formal and informal meetings.	
d. Describe the components of an effective oral presentation of a job plan.	
e. Describe documentation requirements associated with such tasks as processing maintenance check-sheets, work orders, commission reports, inventory control, and performance appraisals.	
f. Describe Labour related Acts and regulations.	
2. Interpret instruction manuals.	14%
3. Write business letters and memos.	13%
4. Organize, write, and produce technical documents.	13%
5. Write instructions/procedures, and describe a process.	14%
6. Write job resumes and job application letters.	13%

Power Electrician

Unit: A6 Trade Safety Awareness

Level: One

Duration: 10 hours

Theory: 10 hours

Practical: 0 hours

Overview:

Safe working procedures and conditions, injury prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers, and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and environments can be created by controlling the variables and behaviours that may contribute to incidents or injury. It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe, and accident-free working environment. It is imperative to apply and be familiar with the Workplace Safety and Health Act and Regulations. As well, it's essential to determine workplace hazards and take measures to protect oneself, co-workers, the public, and the environment. Safety education is an integral part of Insulator apprenticeship training both in school and on-the-job. Unit content is supplemented throughout technical training by trade-specific information about Insulator safety hazards and precautions presented in the appropriate contexts of discussion and study.

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. A Pass mark is still assumed to be 70% and therefore 70% is the mark to be submitted to the Apprenticeship Manitoba clerks for inputting into the computer records.

Objectives and Content:

**Percent of
Unit Mark (%)**

1. Identify safety and health requirements.

n/a

- a. Overview of The Workplace Safety and Health Act
 - Rights and responsibilities of employees under the Act
 - Rights and responsibilities of employers under the Act
 - Rights and responsibilities of supervisors under the Act
- b. Fourteen (14) regulations
- c. Codes of practice
- d. Guidelines
- e. Right to refuse
 - Explanation of right to refuse process
 - Rights and responsibilities of employees
 - Rights and responsibilities of employers
 - Rights and responsibilities of supervisors under the Act

2. Identify personal protective equipment (PPE) and procedures.

n/a

- a. Employer and employee responsibilities as related to personal protective equipment.

- b. Standards: ANSI (U.S.A. standards), etc.
 - c. Work protective clothing and danger if it fits poorly.
 - d. Gloves – Importance of proper glove selection (when handling chemicals, cold items, slivers, etc.)
 - e. Headwear – appropriate protective headwear when required and the approved type of headwear.
 - f. Eye protection – comparison and distinction of everyday eyeglasses, Power safety glasses and safety goggles
 - g. Foot protection – when required according to safety standards
 - h. Hearing protection
 - Hazards of various noise levels (hearing protection must be worn)
 - Laws
 - Types of hearing protection
 - i. Respiratory protection – types, overview of proper selection
 - j. Fall protection – Manitoba requirements standards guidelines
 - ANSI (U.S.A. standards), etc.
 - k. Ladders and scaffolding
 - l. Safety principles for working with or around Power trucks site-specific (forklifts, pallet trucks, etc.)
- 3. Identify electrical safety. n/a**
- a. Effects of electric current on the human body
 - b. Three factors that affect the severity of an electric shock
 - c. The effects of ARC and blast on the human body and equipment
 - d. Work with energized equipment
- 4. Identify fire safety. n/a**
- a. Types of fires
 - b. Types of fire fighting equipment
 - c. Classifications of fire extinguishers (A, B and C)
 - d. Location of fire extinguishers and fire exits
 - e. Fire alarms and drills
- 5. Identify ergonomics. n/a**
- a. Definition of ergonomics and conditions that may affect the body
 - Working postures
 - Repetition
 - Force
 - Lifting
 - Tools
 - Identify tool and safety equipment
 - Causes of hand tool accidents
 - Equipment
- 6. Hazard recognition and control. n/a**
- a. Safe work practices
 - b. Basic risk assessment
 - c. Injury prevention and control measures
 - d. Identification of hazards involved in pneumatic tool use and explanation of how to guard against them

- 7. Hazard of confined space entry:** n/a
- a. Identification of a confined space
 - b. Hazards of a confined space
 - Physical
 - Biological
 - c. Working in a confined space
 - d. Emergency response plan
 - e. Self contained breathing apparatus (SCBA)
- 8. Identify First Aid/CPR:** n/a
- a. Overview of First Aid Regulation
 - b. Obligations of employers regarding First Aid
 - Who is certified to provide First Aid?
 - What to do while waiting for help?
 - Where is First Aid kit?
 - c. Describe basic First Aid requirements and techniques
 - Scope and limits of First Aid intervention
 - Specific interventions (cuts, burns, abrasions, fractures, suffocation, shock, electrical shock, etc.)
 - What is it?
 - Interface with other services and agencies (eg. Workers Compensation claims)
 - d. Describe basic CPR requirements and techniques
 - How do you get certified?
 - Scope and limits of CPR intervention (include varieties of CPR certification)
- 9. Identify the safety requirements as they apply to WHMIS with emphasis on:** n/a
- a. WHMIS is a system
 - b. Provincial Regulation under the Safety and Health Act
 - Each province has a WHMIS regulation
 - c. Federal Hazardous Products Act
 - d. WHMIS generic training:
 - WHMIS defined and the format used to convey information about hazardous materials in the workplace
 - Information found on supplier and workplace labeling using WHMIS
 - Hazardous materials in accordance with WHMIS
 - Compliance with government safety standards and regulations
 - e. Description of WHMIS (include varieties of WHMIS Certification)
 - Typology of WHMIS labels, symbols, and classifications
 - Scope and use of Materials Safety Data Sheets (MSDS)
- 10. Identifying and controlling hazards:** n/a
- a. Basic control measures (injury prevention)
 - b. Safe work procedures
 - c. Explanation on the importance of Power housekeeping
 - d. Employer responsibilities
 - e. How and where to store materials
 - f. Safety measures related to walkways, stairs and floor openings
 - g. Explanation of how to protect the worker and others when working in traffic paths
