Apprenticeship Manitoba

Manitoba

Power Electrician
Level 4

Rev. September 2008

Apprenticeship Manitoba

Power Electrician

Unit: D1 Electrical Code IV

Level: Four

Duration: 45 hours

Theory: 45 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with complex knowledge and understanding of the Canadian Electrical Code and the Manitoba Regulation with respect to heavy industrial, hazardous and high-voltage installations.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe and apply rules for signaling systems. (Fire Alarms).	**10%**
2. Describe and apply rules for PLC / Data Infrastructure: a. Fiber optic cable b Electrical communications system	**10%**
3. Describe and apply rules for power factor correction.	**10%**
4. Describe and apply rules for HVAC systems.	**10%**
5. Describe and apply rules for system protection including short circuit calculations.	**10%**
6. Describe and apply rules for harmonics.	**15%**
7. Describe and apply rules for hazardous locations including class 1 and 2 locations.	**15%**
8. Describe program content by reviewing levels 1 through 3.	**20%**

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Apprenticeship Manitoba

Power Electrician

Unit: D2 Microprocessor-based Control and Monitoring systems (PLCs) and Control Systems

Level: Four

Duration: 45 hours

Theory: 20 hours

Practical: 25 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with complex knowledge and understanding of PLCs. The unit is intended to supplement the information taught in print reading, electrical code and electrical concepts.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe requirements for programming PLC for industrial control and annunciation application using PLC ladder logic, as well as more common programming languages.	**20%**
2. Describe the varying capabilities of different PLCs.	**8%**
3. Describe the use of a PC for accessing programs and monitoring specific inputs/outputs or processes, uploading, downloading, and file management of programs.	**8%**
4. Describe I/O operations/communication protocols related to PLC and networking potential.	**16%**
5. Describe requirements for analyzing/testing common interface standards used in communication and data-acquisition systems for industrial controls: a. Where PLC control or annunciator is integrated into a traditional control system b. Other.	**12%**
6. Implement shielding, grounding and isolation solutions in plant environments: a. Electrical noise suppression in control and communication cables b. Isolation for floating electrical devices c. Optical isolation for long distance communication cables d. Other	**2%**
7. Analyze and troubleshoot computer grounding problems.	**2%**
8. Apply basic principles and functions of programmable logic, including digital inputs/outputs, analog inputs/outputs, logic gate networks, counters, timers, registers, shift registers, gates and memory, memory maps, logic math,	**16%**

sequencers and scan cycle/time.

9.	**Program PLC for industrial control and annunciation application using PLC ladder logic, as well as more common programming languages.**	**6%**
10.	**Analyze system problems and take corrective action.**	**2%**
11.	**Use remote I/O operations/communication protocols related to PLC and networking potential.**	**2%**
12.	**Analyze and test common interface standards used in communication and data-acquisition systems for industrial controls:** a. Where PLC control or annunciator is integrated into a traditional control system b. Other	**2%**
13.	**Apply basic principles/functions of programmable logic, analog inputs/outputs.**	**2%**
14.	**Design & demonstrate motor control circuits and application by use of sensing devices:** a. Temperature sensing devices (e.g., RTD) b. Hall effect sensors.	**2%**

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Apprenticeship Manitoba

Power Electrician

Unit: D3 Electronic Concepts III (Power Electronics)

Level: Four

Duration: 82 hours

Theory:	82	hours
Practical:	0	hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with an understanding of power circuits such as rectifiers, converters, inverters and AC voltage controllers along with the power components used in such circuits such as: power diode, SCR, GTO and IGBT. Attention is focused on the nature of harmonics produced by these power circuits, the problems associated with harmonics and what remedies are available. Special emphasis is placed on those applications that will be encountered by a Power Electrician such as variable frequency motor drives for cooling pumps and the major constituent circuits of an HVDC system.

Objectives and Content: **Percent of Unit Mark (%)**

1. Describe power electronic devices. **12%**

a. Describe the characteristics of power diodes:
- Symbol
- Characteristic graph
- Voltage and current ratings
- Package types
- Ohmmeter test
- Huntron-Tracker Test

b. Describe and apply the characteristics of silicon controlled rectifiers:
- Characteristic graph
- Voltage and current ratings
- Turn ON time, turn OFF time and maximum switching rate
- Heat dissipation due to switching
- Types of gate signals
- How load type determines gate signal type
- Package types
- Ohmmeter test
- Huntron-Tracker Test

c. Describe the characteristics of GTO:
- Symbol
- Turn ON and Turn OFF mechanism
- Maximum switching rate

d. Describe and apply the characteristics of TRIAC:
- Symbol
- Turn ON modes

- Limitations with respect to maximum available current rating, load frequency and type of load

e. Describe the characteristics of power transistor:
   - Symbol
   - Turn ON and Turn OFF mechanism
   - Maximum switching rate

f. Describe the characteristics of IGBT:
   - Symbol
   - Turn ON and Turn OFF mechanism
   - Maximum switching rate.

2. Describe AC voltage controller, phase control type. 8%

a. Describe , identify and apply voltage waveforms along with firing angle and conduction angle in a single phase voltage controller for the following:
   - SCR/TRIAC voltage waveform
   - Load voltage waveform

b. Describe, identify and apply line current waveform with firing angle and conduction angle in a single phase voltage controller
c. Describe use of graph to calculate RMS load voltage vs. firing angle
d. Describe use of graph to calculate power delivered to load versus firing angle
e. Describe practical range of firing angle
f. Describe and apply spectral display of line current harmonics
g. Describe how line current harmonics produce heat loss
h. Describe problem of EMI as a consequence of di/dt.

3. Describe gat circuits. 13%

a. Describe methods of electrically isolating gate circuit from power circuit:
   - Pulse transformer
   - Optical isolation

b. Describe and apply operation of representative gate circuits with pulse transformer isolation:
   - Single phase gate circuit
   - Three phase gate circuit.

4. Describe rectifiers. 19%

a. Describe characteristics of single phase bridge rectifier:
   - Output voltage waveform for normal operation and for various malfunctions
   - Output current waveform for operation with series inductor
   - Pulse output
   - Average output voltage
   - Significant output voltage harmonics
   - Output DC equivalent circuit
   - Output AC equivalent circuit
   - Input waveforms: voltage and current
   - RMS value of line current
   - Line current harmonics
   - Input power: active, reactive, apparent
   - True power factor
   - Diode voltage and current ratings
   - Transformer KVA rating

b. Describe and apply characteristics of three phase bridge rectifier:
   - Output voltage waveform for normal operation and for various malfunctions
   - Output current waveform for operation with series inductor
   - Pulse output

- Average output voltage
- Significant output voltage harmonics
- Output DC equivalent circuit
- Output AC equivalent circuit
- Input waveforms: voltage, current
- RMS value of line current
- Line current harmonics
- Input power: active, reactive, apparent
- True power factor
- Diode voltage and current ratings
- Transformer KVA rating

c. Describe characteristics of twelve pulse rectifier system, series configuration:
- Output voltage waveform for normal operations
- Output current waveform for operation with series inductor
- Average output voltage
- Pulse output
- Significant output voltage harmonics
- Input waveforms: voltage, current
- RMS value of line current
- Line current harmonics
- Input power: active, reactive, apparent
- True power factor
- Diode voltage and current ratings
- Transformer KVA rating.

5. Describe converters. 13%

a. Describe characteristics of single phase bridge full converter:
- Output waveforms: voltage, current
- Average output voltage
- Pulse output
- Output voltage harmonics
- Output DC equivalent circuit
- Quadrants of operation
- Modes of operations: rectifier mode, inverter mode
- SCR misfire in rectifier mode
- Practical range of firing angle
- Input waveforms: voltage, current
- RMS value of line current
- Line current harmonics
- Input power: active, reactive, apparent
- True power factor
- SCR voltage and current ratings
- Transformer KVA rating

b. Describe and apply characteristics of three phase bridge full converter:
- Output waveforms: voltage, current
- Average output voltage
- Pulse output
- Output voltage harmonics
- Input waveforms: voltage, curerent
- RMS value of line current
- Input power: active, reactive, apparent
- True power factor
- SCR voltage and current ratings

- Transformer KVA rating

c. Describe characteristics of single phase half converter:
   - Output waveforms: voltage, current
   - Average output voltage
   - Mode of operation
   - Input waveforms: voltage, current

d. Describe characteristics of three phase half converter:
   - Average output voltage

e. Describe type of converter associated with the following representative applications:
   - Battery charger
   - Voltage regulator for alternator
   - Cogeneration with wind power.

6. Describe power filters. **6%**

a. Describe characteristics of AC power filter, series resonant type:
   - Characteristic graph of impedance versus frequency
   - Filter resonant frequency versus harmonic frequency
   - Calculation of filter component values
   - Filter circuit for three phase, three conductor AC source
   - Filter circuit for three phase, four conductor AC source
   - Filter location
   - Input filter line current versus output filter line current
   - Effect of filter on: apparent power demand, transformer heat dissipation, power factor capacitor heat dissipation, conductor heat dissipation

b. Describe characteristics of DC power filter, series resonant type:
   - AC equivalent circuit and example calculation
   - Filters required for six pulse operation
   - Filters required for twelve pulse operation.

7. Describe HVDC. **6%**

a. Describe the advantage of long distance power transmission with HVDC system versus AC system with respect to:
   - Relative cost of construction
   - Protection
   - Stability

b. Describe components of monopole HVDC transmission system

c. Describe components of bipole HVDC transmission system

d. Describe operation of HVDC system:
   - Rectifier characteristic graph
   - Inverter characteristic graph
   - Control of power transmitted
   - Reaction to fluctuations in AC source voltage
   - Reaction to line to ground fault.

8. Describe inverters. **6%**

a. Describe applications of inverters:
   - Portable battery operated AC power supply for power tools and appliances
   - UPS for computer
   - Variable frequency drive for AC motor

b. Describe characteristics of single phase bridge VVI inverter:
   - Output voltage waveform
   - Output voltage control
   - Output frequency control

c. Describe characteristics of single phase bridge PWM inverter:

- Output voltage waveform
- Output voltage control
- Output frequency control

d. Describe characteristics of three phase bridge VVI inverter:
   - Output voltage waveform
   - Output voltage control
   - Output frequency control
   - Output voltage harmonics

e. Describe characteristics of three phase bridge PWM inverter:
   - Output voltage waveform
   - Output voltage control
   - Output frequency control
   - Output voltage harmonics

f. Describe comparison of PWM inverter versus VVI inverter with respect to output voltage harmonics.

9. Describe types of mechanical loads. 4%

10. Describe soft start AC motor controller. 4%

11. Describe variable frequency drive. 9%

a. Describe torque versus RPM graph for AC induction motor and identify modes of operation:
   - Motor mode
   - Generator mode
   - Brake mode

b. Describe how AC motor torque depends on voltage and frequency applied to motor terminals

c. Describe ideal torque versus RPM graph for AC motor operating at constant V/Hz. ratio and below name plate voltage and frequency

d. Describe ideal line current versus RPM graph at constant V/Hz. ration for operation below name plate voltage and frequency

e. Describe basic linear graph of output voltage versus frequency for VFD:
   - Rated output voltage
   - Knee frequency
   - Maximum frequency
   - Constant torque load versus variable torque load

f. Describe basic quadrant graph of output voltage versus frequency for VFD:
   - Rated output voltage
   - Knee frequency
   - Maximum frequency
   - Constant torque load versus variable torque load

g. Describe methods of deceleration:
   - Dynamic braking
   - Regenerative braking

h. Describe DC injection braking

i. Describe, identify and compare VFD types:
   - PWM VFD
   - VVI VFD

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Apprenticeship Manitoba

Power Electrician

Unit: D4 Power Quality

Level: Four

Duration: 13 hours

Theory: 13 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with knowledge and understanding of power quality.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify characteristics of a sustained, temporary and momentary power interruption.	**11%**
2. Indentify the characteristics of voltage sag, voltage swell, over and under voltage condition, voltage fluctuation and voltage transient.	**11%**
3. Describe the operation of different types of uninterruptible power supplies (UPS) systems. a. Standby generator b, Battery charger/battery bank c. Electronic converters	**11%**
4. Describe surge suppression and how it is applied to transmission lines, primary distribution centers and secondary circuits. a. Lightning arrestors b, Metal oxide varistors (MOV)	**11%**
5. Describe the effects of linear and non-linear loads on the electrical distribution system.	**11%**
6. List the frequency of different order harmonics.	**11%**
7. Identify the electrical effects that are caused by negative, positive and zero sequence harmonics to transformers, circuit breakers and neutral conductors.	**11%**
8. Describe the effects of harmonic currents on motors, capacitors and sensitive electronic equipment.	**11%**
9. Describe the displacement power factor, total harmonic distortion (THD) and transformer K-Rating.	**12%**

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Apprenticeship Manitoba

Power Electrician

Unit: D5 Digital Logic Concepts

Level: Four

Duration: 40 hours

Theory: 25 hours

Practical: 15 hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with complex knowledge and understanding of electronic concept applications.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe flip-flop circuits such as frequency-division and counting circuits.	**8%**
2. Describe requirements for handling/storing semiconductor digital devices according to manufacturer specifications and approved handling procedures.	**3%**
3. Describe requirements for performing conversions between hexadecimal, decimal, binary, ASCII and BCD-based coding systems.	**3%**
4. Describe requirements for programming logic devices for simple applications.	**1%**
5. Describe requirements for selecting semiconductor digital devices for given applications using manufacturer data-sheets.	**2%**
6. Describe requirements for troubleshooting interfaces for different types of logic families.	**2%**
7. Describe requirements for using Boolean algebra and basic Karnaugh maps to simplify logic circuits.	**6%**
8. Describe requirements for using manufacturer's external device markings and data-sheets to identify type, case style, maximum ratings and electrical characteristics of integrated circuits.	**6%**
9. Describe requirements for analyzing/troubleshooting combinational logic circuits.	**3%**
10. Describe requirements for analyzing/troubleshooting digital multiplexing circuits.	**2%**
11. Describe requirement for analyzing/troubleshooting logic circuits which use tri-state gates, latches and buffers.	**10%**

12.	**Describe requirements for analyzing, constructing and troubleshooting counter and register circuits, encoder/decoder circuits, multiplexer/ demultiplexer circuits and Shmitt trigger circuits.**	**12%**
13.	**Describe requirements for applying LEDs and LCDs for logic circuit applications.**	**3%**
14.	**Describe requirements for configuring sequential counters to quantify predetermined sequences.**	**2%**
15.	**Analyze and troubleshoot flip-flop circuits such as frequency-division and counting circuits.**	**7%**
16.	**Handle and store semiconductor digital devices according to manufacturer specifications and approved handling procedures.**	**2%**
17.	**Perform conversions between hexadecimal, decimal, binary, ASCII and BCD-based coding systems.**	**3%**
18.	**Program logic devices for simple applications.**	**4%**
19.	**Select semiconductor digital devices for given applications using manufacturer data-sheets.**	**1%**
20.	**Troubleshoot interfaces for different types of logic families.**	**2%**
21.	**Use Boolean algebra and basic Karnaugh maps to simplify logic circuits.**	**4%**
22.	**Use manufacturer's external device markings and data-sheets to identify type, case style, maximum ratings and electrical characteristics of integrated circuits.**	**1%**
23.	**Analyze and troubleshoot analog-to-digital and digital-to-analog conversion circuits.**	**1%**
24.	**Analyze and troubleshoot combinational logic circuits.**	**3%**
25.	**Analyze and troubleshoot logic circuits which use tri-state gates, latches and buffers.**	**3%**
26.	**Analyze, construct and troubleshoot counter and register circuits, encoder/decoder circuits, multiplexer/demultiplexer circuits and Shmitt trigger circuits.**	**4%**
27.	**Apply LEDs and LCDs for logic circuit applications.**	**1%**
28.	**Configure sequential counters to quantify predetermined sequences.**	**1%**

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Apprenticeship Manitoba

Power Electrician

Unit: D6 Relay and Protection Systems

Level: Four

Duration: 39 hours

Theory: 39 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with complex knowledge and understanding of relay and protection systems.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe the theory/applications required t operate protective relaying components of a power system.	**3%**
2. Describe the theory/applications required to operate auxiliary relays. a. Annunciating b. Regulating c. Lockout/non-lockout d. Other	**3%**
3. Describe zone protection.	**3%**
4. Describe the theory/applications for the operation of electromagnetic, electronic, microprocessor-based relays. a. Over-current b. Voltage c. Differential d. Impedence e. Directional	**50%**
5. Describe theory/application associated with various pilot protection relays. a. Pilot wire relay b. Powerline carrier c. Microwave d. Fibre-optic e. Other	**10%**
6. Describe theory/applications required to operate various special purpose relays. a. Current balance relays b. Frequency protection relays c. Generator protections (motoring) relays	**28%**

d. Negative sequence relays
e. Reverse power relays
f. Phase comparison

7. Describe cathodic protection. 3%

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Apprenticeship Manitoba

Power Electrician

Unit: D7 Governor/Excitation Equipment

Level: Four

Duration: 21 hours

Theory: 21 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Power Electrician apprentice with advanced knowledge and understanding of governor and excitation equipment.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe mechanical/hydraulic governor hydraulic operating systems (theory and application).	**10%**
2. Describe electrical, electronic and digital governor control systems and how they are integrated into the hydraulic governor.	**15%**
3. Describe PMG and ball head motor for speed control.	**1%**
4. Describe speeder motor, its purpose, its limit and best gate and full gate controls.	**1%**
5. Describe solenoids, their purpose and control.	**1%**
6. Describe wicket gate limits.	**1%**
7. Relate the electrical controls and their actions to the hydraulic system.	**1%**
8. Describe magnetism, DC machine theory: a. Series b. Shunt c. Compound d. Wound rotor generators and motors e. Other	**5%**
9. Describe slop rings and commutators.	**5%**
10. Describe armature reaction, its compensation, interpoles, machine commutator neutral and full load running neutral.	**5%**
11. Describe magnetism, AC machine theory. a. Single phase	**5%**

b. Three phase
c. Synchronous generators and motors
d. Other.

12. Describe solid state excitation equipment system technology and the equipment involved, including high power rectifiers, SCRs and their associated feedback, control and amplifier circuits. **5%**

13. Describe pilot exciters and their control. **5%**

14, Describe main exciters and their control. **5%**

15. Describe field rheostats and their operation. **5%**

16. Describe automatic voltage regulators, their operation and control, including sold state AVR, saturation transformer AVR, quick acting (torque motor) AVR. **5%**

17. Describe amplidynes, their characteristics, uses and control. **5%**

18. Describe various excitation limiters: **5%**
a. Minimum excitation limiter
b. Maximum excitation limiter
c. Other.

19. Describe field rheostat follow-up circuits for unit voltage control if AVR fails. **5%**

20. Describe field breakers, their function and their operation. **5%**

21. Follow and trace the operations or control of a device through a complex set of electronic/electrical schematics, wiring diagrams, interconnection drawings and manuals. **5%**

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Apprenticeship Manitoba

Power Electrician

Unit: D8 Metering

Level: Four

Duration: 30 hours

Theory: 30 hours

Practical: 0 hours

Overview:

This unit of instruction s designed to provide the Power Electrician apprentice with the supporting knowledge competencies for metering.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe basic workings of meters (e.g., volt meters, ammeters) including full-scale deflection, extended ranges and loading error.	**10%**
2. Describe current and potential transformers, accuracy and burden.	**10%**
3. Describe specific requirements for customer, station and power sales agreement (PSA) metering.	**10%**
4. Describe hazards associated with metering systems (e.g. potential transformer primary, current transformer open circuits, bus clearances).	**10%**
5. Describe polarity marks, vectors and phase angles in regards to metering systems.	**10%**
6. Describe metering systems (e.g., single-phase, 3 phase-Wye, 3 phase-Delta, 3 phase 4 wire-Delta, 3 phase-Wye/Delta).	**10%**
7. Describe types of meters (energy, kilowatt demand, kilovoltamp demand, digital pulse and digital recording).	**10%**
8. Describe digital and analog recording meters.	**10%**
9. Describe metering transducers (e.g., volt, amp, watt and var).	**10%**
10. Describe test instruments (e.g., power-circuit analyzer) used to determine problems with power service to customers (e.g., harmonics, power factor).	**10%**

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Apprenticeship Manitoba

Power Electrician

Unit: D9 Provincial Electrical Requirements

Level: Four

Duration: 35 hours

Theory:	35	hours
Practical:	0	hours

Overview:

This unit offers senior apprentices a systematic review of skills and knowledge required to pass the Provincial "Gold Seal" Examination. It promotes a purposeful personal synthesis between on-the-job learning and the content of in-school technical training. The unit includes pertinent information about the broad significance of Gold Seal Provincial certification and the main features of the Provincial exam. Trade-specific content is enriched with information about practical strategies/resources for mastering study materials. It is intended that apprentices who seriously tackle the objectives of this unit should be able to approach the Provincial exam with well-founded confidence. But the unit also promotes a consolidation of study practices, trade knowledge, and self-awareness to help meet the longer-term requirements of further learning throughout one's working life as a certified journeyperson.
Note: No percentage-weightings for test purposes are prescribed for this unit's objectives. A "Pass/Fail" grade will be recorded for the unit. A Pass mark is assumed to be 70%. Therefore 70% is the mark to be submitted to the Apprenticeship Manitoba clerks for inputting into computer records.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe the significance, format, and general content of Provincial (Gold Seal) Examinations for the trade of Power Electrician.	**n/a**

a. Scope and aims of Provincial Certification system; value of certification
b. Obligations/entitlements of candidates for Provincial certification
   - Relevance of Provincial Examination to current, accepted trade practices; industry-based national validation of test items
   - Supplementals Policy (retesting) of the Apprenticeship Manitoba
   - Confidentiality of examination content; the certified journeyperson's own stake in examination security (value of credential)
   - Limitations on use of calculators (e.g. dedicated, pre-programmed builders' calculator not allowed)
c. Multiple-choice (four-option) item format; Provincial Gold Seal/Apprenticeship Manitoba standards for acceptable test items (e.g., no "trick"-type questions; specifications for use of metric/Imperial units)
d. Important government materials relevant to the Provincial Examination for apprentice Power Electricians
   - Provincial Occupational Analysis (POA); prescribed scope of the skills and knowledge which comprise the trade
   - POA "Pie-chart" and its relationship to content-distribution of Provincial Examination items
   - Manitoba Apprentice Portfolio, especially the POA-based Practical Record Book and task/subtask checklists as these relate to apprentice's coverage of the skills and knowledge of his/her trade
   - Canadian Electrical Code relationship to examination content; availability of CEC

excerpts to Provincial candidates during examination.

2. Identify resources, strategies, and other key considerations for maximizing successful completion of written exams used in certifying tradespeople. **n/a**

a. Personal preparedness
- Proper rest/nutrition; eye-testing
- Making room for a personal study regimen: appropriate prior communication with family members, friends, and employers about exam-related commitments/needs; identifying – and concluding – all necessary arrangements for minimizing distractions/disruptions
- Focused reflection on prior experience – good and bad -- in test situations (e.g., Unit Tests), especially with respect to what the apprentice already has learned about his/her own personal characteristics, learning styles, exam anxiety, and strategies (e.g., time management) for effective performance in test situations.

b. Self-assessment, consultation, and a Personal Study Plan
- Preliminary self-assessment of individual strengths/weaknesses in trade-related skills and knowledge; usefulness of old tests; usefulness of Apprenticeship Portfolio checklists and reflection on both the in-school and on-the-job components of the Apprenticeship Program in the Power Electrician Trade, as well as the inter-relationship between these two components; usefulness of consultation with journeypersons, appropriate peers, the Apprenticeship Counsellor and/or other trade mentors
- Use(s) of approved textbooks, chapter tests, study guides, and note-taking in preparing for an examination
- Study groups: perils and possibilities
- Formulation, and submission for instructor's comments, of a personal study plan, including an approximate timetable, which describes/schedules a course of action for reviewing all relevant material(s) and for strengthening areas of deficient skills/knowledge in anticipation of the Provincial Gold Seal Examination.

3. Review program content re: Print Reading and Canadian Electrical Code. **n/a**

4. Review program content re: Communications. **n/a**

5. Review program content re: Mathematics and Science Fundamentals. **n/a**

6. Review program content re: Electrical Fundamentals. **n/a**

7. Review program content re: Three Phase Theory and Transformers. **n/a**

8. Review program content re: Electronics. **n/a**

9. Review program content re: PLCs and Controls. **n/a**

10. Review program content re: Motors, Generators, Excitation and Governor Equipment. **n/a**

11. Review program content re: Relays and Protection. **n/a**

12. Review program content re: Governor and Excitation. **n/a**

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