Apprenticeship Manitoba

Manitoba

Power Electrician
Level 3

Rev. September 2008

Apprenticeship Manitoba

Power Electrician

Unit: C1 Electrical Code III

Level: Three

Duration: 60 hours

Theory: 60 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with knowledge and understanding of the Canadian Electrical Code. On satisfactory completion, the apprentice-learner will be able to describe contract documents and drawings, busways, trolley busways, lightning protection, lighting, data infrastructure, harmonics, describe and calculate installation of conductors in raceways, free air and underground, main service requirements for main services and feeder subpanels (building calculations three phase plus single), installation of transformers, motors (single and group motors), in addition to reviewing single phase voltage drop, three phase voltage drop, continuous loading, conductor derating and system voltages and will apply code regulations where applicable.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe contract documents and drawings:	**7%**
a. Identify Contract documents	
b. Identify Layout of specifications	
c. Identify the Drawings in a typical construction drawing set	
d. Read site plans to determine the locations of specific items	
2. Decribe busways.	**2%**
a. State the benefits of using busways	
b. Identify common applications of busways	
c. List the components of busways	
d. Describe various support systems	
3. Describe trolley busways:	**2%**
a. Identify features of a trolley busway installation	
b. Select components to support cord drops	
4. Describe lighting protection.	**2%**
a. Describe the lightning process	
b. Identify the requirements for protecting a building	
c. List lightning safety rules.	
5. Describe lightning	**3**
a. List the import consideration in lamp selection for lighting systems	
b. Select illuminance values for site lighting	
c. Compute the power limit and power demand for site lighting	

d. Locate luminaires (fictures for site lightning)
e. List control options for lighting systems

6. Describe harmonics. 5%

a. Describe a harmonic
b. Discuss the problems concerning harmonics
c. Identify the characteristics of different harmonics
d. Perform a test to determine whether harmonic problems exist
e. Discuss the methods of dealing with harmonic problems

7. Describe and calculate installation of conductors in raceways, free air and underground. 22%

a. Single raceways, MI, AI sheath, Teck, AC
b. Parallel raceways, MI, AI sheath, Teck, AC
c. Section 16

8. Describe and calculate main service requirements for main services and feeder subpanels (building calculation single phase and three phase) 13%

a. Small industrial building
b. Schools, hospitals, motels, hotels

9. Describe and calculate installation of transformers and capacitors. 17%

a. Transformers single and three phase installations – all type
b. Primary and secondary O.C.P. conductors, bonding and grounding

10. Describe the installation of Motors (single motors and group of motors. 16%

a. Single phase Ac (individual)
b. Three phase AC (individual)
c. DC individual
d. Carious duty cycles continuous, intermitting, varying, periodic, shorttime

11. Describe for review purposes single phase voltage drop, three phase voltage drop, continuous loading, conductor derating and system voltages. 8%

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Power Electrician

Unit: B2 AC Fundamentals

Level: Three

Duration: 90 hours

Theory:	90	hours
Practical:	0	hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with intermediate knowledge and understanding of AC fundamentals. The apprentice will describe and calculate requirements for calculating apparent power, true power, reactive power, and power factor in LR and CR circuits, calculating time periods and wavelengths of sine waves, and the instantaneous peak, average, and root mean square levels of current in resistors when sinusoidal voltages are applied, calculating resonant frequency, bandwidth, Q, and frequency response in series/parallel RLC circuits, analyzing RLC circuits and calculating impedance, voltage, current, power, and phase relationships in RC, RL, and RLC series/parallel circuits, and analyzing AC circuits and networks using Kirschoff's voltage/current laws.

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

1. Sinusoidal Alternating Current (AC). **11%**

a. Describe AC voltage and current.
b. Describe how an AC voltage and current is produced.
c. Describe voltage polarity and current direction conventions for AC.
d. Describe and relate frequency and period of a periodic waveform.
e. Describe and relate degrees and radians.
f. Describe a sinusoidal waveform mathematically as a function of time and calculate instantaneous values.
g. Describe and apply phasor (vector) notation to represent AC voltages and currents.
h. Describe and represent voltages and currents with phase shifts and determine phase shifts between voltages and currents.
i. Describe and calculate average values for sinusoidal waveshapes.
j. Describe the effective (RMS) concept, and calculate effective values for sinusoidal waveforms.

2. Response of Basic RLC Elements to Sinusoidal Voltage or Current. **22%**

a. Describe and represent phasor voltages and currents using complex numbers.
b. Describe and solve AC circuits with purely resistive load using Ohm's Law.
c. Describe and calculate the inductive reactance and solve AC circuit with purely inductive load.
d. Describe capacitors and capacitance.
e. Describe and calculate the capacitive reactance and solve AC circuit with purely capacitive load.
f. Describe the impedance concept and compute impedance for R, L and C circuit elements.
g. Describe and solve a few simple AC circuit problems using the impedance method.

h. Describe and represent phasor voltages and currents using complex numbers.
i. Describe and solve AC circuits with purely resistive load using Ohm's Law.

3. AC Power. **18%**

a. Describe instantaneous, apparent, true and reactive power.
b. Describe and calculate apparent, true, reactive powers and power factor for an AC circuit.
c. Describe and apply power factor correction.
d. Describe how power is measured using a wattmeter.
e. Describe effective resistance and skin effect.

4. Series and Parallel AC Circuits. **38%**

a. Describe and calculate the total impedance of a series AC circuit.
b. Describe and apply Ohm's Law, KVL and VDR while solving AC series circuits for voltages, current and power.
c. Describe and calculate the total impedance of a parallel AC circuit.
d. Describe and apply Ohm's Law, KCL and CDR while solving parallel AC circuits for voltage, current and power.
e. Describe and sketch the power triangle and use it to solve power problems.
f. Describe and calculate power factor.

5. Combination AC Circuits. **11%**

a. Describe and calculate total impedance of a complex RLC circuit.
b. Describe and solve RLC complex networks using Ohm's Law, KVL, KCL, VDR, CDR.
c. Describe and calculate real power and power factor for the given circuit.

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Apprenticeship Manitoba

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Unit: B3 Control Systems (integrated building systems such as instrumentation devices, annunciation systems and HVAC systems)

Level: Three

Duration: 70 hours

Theory: 45 hours

Practical: 25 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with the basic knowledge and understanding of control systems (integrated building systems such as instrumentation devices, annunciation systems and HVAC systems).

Objectives and Content:	**Percent of Unit Mark (%)**
1. Motor Controls.	**36%**

a. Describe the general principles of electric motor controls, state the difference between manual and remote control.
b. Describe the conditions that affect the motor controller in regards to starting and stopping.
c. Describe fractional and integral horsepower manual motor starters with reference to size, uses, and overload protection.
d. Describe magnetic line voltage motor starters with reference to: operation, sizing, uses, remote control, shaded pole principle.
e. Describe the operation of and sizing for overload heaters and overload relays.
f. Describe push buttons, selector switches and control stations.
g. Draw and interpret simple circuits using push buttons, selector switches and control stations.
h. Describe the operation and recognize the schematic symbols for various pilot devices such as:
   - Pressure switches
   - Float switches
   - Flow switches
   - Limit switches.
i. Draw and interpret basic control circuits with reference to two and three-wire control circuits.
j. Describe the difference between schematic and wiring diagrams.
k. Develop schematic and wiring diagrams from written instructions.
l. Describe jogging control circuits.
m. Describe forward/reversing magnetic motor starters and interlocking methods for forward and reverse control, push button interlock, contact interlock.
n. Describe schematic and wiring diagrams for sequence control.
o. Draw and interpret schematic diagrams for sequence control.

p. Describe the use, ratings and operation of relays and contactors.
q. Describe the operation of magnetic blowout coils for arc suppression.
r. Describe the uses and advantages of solid state relays.
s. Describe the primary types of timing relays, on delay/off delay, and symbols.
t. Draw and interpret schematic/wiring diagrams using timing relays.
u. Perform Practical Wiring:
   - Stop
   - Start
   - Jog
   - Forward and Reversing
   - Sequence of Operation.

2. Instrumentation applications and devices. 17%

a. Describe typical applications and instrumentation devices used to collect and transmit data on Flow, pressure, motion, temperature, level, volume, weight and vibration.
b. Describe the requirements for selecting, installing, testing and calibrating sensors and transducers for measuring and controlling, temperature, pressure, motion and flow.
c. Describe the safety measures to be taken when installing, calibrating, and troubleshooting board/panel metering and instrumentation devices and associated wiring and hardware (e.g., potential and current transformers).
d. Differentiate between open and closed loop control systems.
e. Describe the requirements for installing, testing and troubleshooting servomechanisms and feedback systems for basic air handling temperature and louver control and motorized valves in cooling and lubricating systems.

3. Annunciation (Monitoring) Systems. 3%

a. Describe theory/applications associated with annunciation and monitoring systems
   - Those based on relay logic
   - Electronics
   - Microprocessors
   - Other

4. HVAC Systems. 8%

a. Describe HVAC systems
b. Interpret schematic/wiring diagrams

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Apprenticeship Manitoba

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Unit: B4 Electronic Concepts I

Level: Three

Duration: 40 hours

Theory: 25 hours

Practical: 15 hours

Overview:

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

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe circuit operations as analog or digital by considering the input and output signals.	**3%**
2. Describe the effect of temperature on conductors and semiconductors.	**3%**
3. Describe the direction of 32 currents and hole currents in semiconductors.	**3%**
4. Describe the difference between majority and minority current carriers in semiconductors.	**3%**
5. Describe the conductivity of PN junction diodes under the conditions of forward and reverse bias.	**3%**
6. Describe the volt-ampere characteristic curves for diodes.	**3%**
7. Identify diode schematic symbols.	**3%**
8. Identify the cathode and anode leads of diodes by examining the case.	**3%**
9. Describe several diode types and their typical applications.	**3%**
10. Recognize half-wave and full wave rectifier configurations.	**3%**
11. Describe the electrical characteristics of the half-wave and full wave rectifier configurations.	**3%**
12. Describe common filter configurations.	**3%**
13. Describe the characteristics of the different filter configurations.	**3%**

14.	**Identify the cathode and anode leads of diodes by testing with an ohmmeter and digital diode tester.**	**5%**
15.	**Predict and measure AC input and DC output voltages for filtered and unfiltered rectifier power supplies.**	**5%**
16.	**Troubleshoot common rectifier power supply malfunctions.**	**6%**
17.	**Describe and draw the symbol for a zener diode and identify the terminals.**	**3%**
18.	**Describe how the zener operates in the breakdown region (reverse voltage) which allows it to be used for voltage regulation.**	**2%**
19.	**Describe the power dissipation of a Zener diode in a regulator circuit.**	**2%**
20.	**Describe the purpose of the current limiting resistor in a Zener diode regulator circuit.**	**2%**
21.	**Identify the schematic symbol and terminal connections of a SCR.**	**2%**
22.	**Describe the operation of a SCR in a DC circuit.**	**2%**
23.	**Describe the operation of a SCR in an AC circuit.**	**2%**
24.	**Describe the terms phase shifting, conduction angle and commutation with reference to a SCR.**	**2%**
25.	**Describe the test method used to test a SCR with an ohmmeter.**	**2%**
26.	**Connect an SCR to control a DC circuit.**	**6%**
27.	**Connect a SCR to control a single phase AC circuit.**	**6%**
28.	**Describe common applications for SCR's in DC and AC circuits.**	**2%**
29.	**Identify the schematic symbol and terminal connections of a Triac.**	**2%**
30.	**Describe the operation of a Triac in an AC circuit.**	**2%**
31.	**Connect a Triac into a circuit to control a resistive load.**	**6%**
32.	**Describe common applications for Triacs controlling AC loads.**	**2%**

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Unit: B5 DC Machines and Controls

Level: Three

Duration: 30 hours

Theory: 20 hours

Practical: 10 hours

Overview:

This unit of instruction is designed to provide the Electrician apprentice with knowledge and understanding of DC Machines and Controls.

Objectives and Content:	**Percent of Unit Mark (%)**
1. DC Generators.	**33%**
a. List the three major types of DC generators.	
b. List the major factors that determine the output voltage produced by DC generators.	
c. Describe the basic operating characteristics between the different types of generators.	
d. Describe the operation of the commutator when used on DC generators.	
e. Discuss the various methods of controlling the output voltage of the different types of DC generators.	
f. Draw schematic diagrams and label the field winding terminals for the different types of DC generators.	**11%**
g. Describe armature reaction and the various methods for correcting its effects.	
h. Discuss the effects of over, under and normal shunt field excitation in shunt and compound generators.	
2. DC Motors.	**27%**
a. List the three major types of DC motors.	
b. Describe the basic operating characteristics of the different types of DC motors.	
c. Describe the operation of the commutator when used on DC motors.	
d. Discuss the various methods of controlling the above and below normal speed of the different types of DC motors.	
e. Draw schematic diagrams and label the field winding terminals of the different types of DC motors.	**11%**
f. Describe the methods of reversing the direction of rotation for the three basic types of DC motors.	
g. Describe the hazards associated with differentially compounded DC motors.	
h. Describe armature reaction and the various methods for correcting its effects.	
i. Discuss speed regulation for the series, shunt and compound motors	
3. DC Motor Controls.	**7%**
a. Describe across the line starting methods used for DC motors.	
b. Describe various methods for controlling armature in rush current.	

c. Describe the purpose of shunt field failure relays.

d. Connect control and power circuits for DC motors that incorporate **11%**

- Across the line starting.
- Definite time acceleration.
- Counter EMF acceleration.
- Above and below normal speed control.

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