

Apprenticeship and Industry Training

Powerline Technician Curriculum Guide

021 (2022)



Apprenticeship
and Industry
Training

ALBERTA ADVANCED EDUCATION

Powerline Technician: apprenticeship education program curriculum guide

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**Powerline Technician
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CURRICULUM GUIDE

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding a sponsor. Sponsors guide apprentices, and support on-the-job learning through provision of mentorship. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyman or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution (PSI) – usually a college or technical institute.

To receive their post-secondary credential, apprentices must learn theory and skills, and they must pass examinations. Criteria for the program—including the content and delivery of technical training—are developed and updated by the Registrar.

The graduate of the Powerline Technician apprenticeship program is an individual who will be able to:

- responsibly do all work tasks expected of a journeyman
- supervise, train and coach apprentices
- use and maintain hand and power tools to the standards of competency and safety required by the trade
- construct, maintain, operate or repair electrical distribution and transmission systems and their equipment
- practice the safe work practices required by the trade
- perform with dexterity the hand skills required to carry out the required mechanical work
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Alberta's apprenticeship programs are supported by industry stakeholders that ensures a highly skilled, internationally competitive workforce in the province. The Registrar establishes the educational standards and provides direction to the system supported by industry and the PSI's. The Ministry of Advanced Education provides the legislative framework and administrative support for the apprenticeship and industry training system.

Special thanks are offered to the following industry members who contributed to the development of the standard:

Mr. R. Phillips.....Calgary
Mr. P. Ryan.....Edmonton
Mr. W. EyolfsonCalgary
Mr. D. Hrushka.....Edmonton
Mr. D. DeathGrande Prairie
Mr. G. DeCuypere.....Lethbridge
Mr. R. LayboltFort McMurray
Mr. C. McClarty.....Camrose

Alberta Government

Alberta Advanced Education works with industry, sponsor and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and sponsors
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, sponsors, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Occupational Health and Safety

Persons engaged in, or supporting an individual in an experiential learning environment are often exposed to more worksite hazards than in other forms of traditional post-secondary education and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Occupational Health and Safety-OHS (a division of Alberta Labour and Immigration) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.alberta.ca/occupational-health-safety.aspx

Technical Training

Apprenticeship technical training is delivered by the PSI's throughout Alberta. The PSI's are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All PSI's place a strong emphasis on safety that complements safe workplace practices towards the development of a culture of safety for all professions.

The PSI's work with industry and Alberta Advanced Education to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs across the province. They develop curriculum from the curriculum guides established by the Registrar in consultation with the PSI's and industry and provide the technical training to apprentices.

The following PSI's deliver Powerline Technician trade apprenticeship technical training:

- Northern Alberta Institute of Technology
- Fortis Alberta
- ATCO Electric

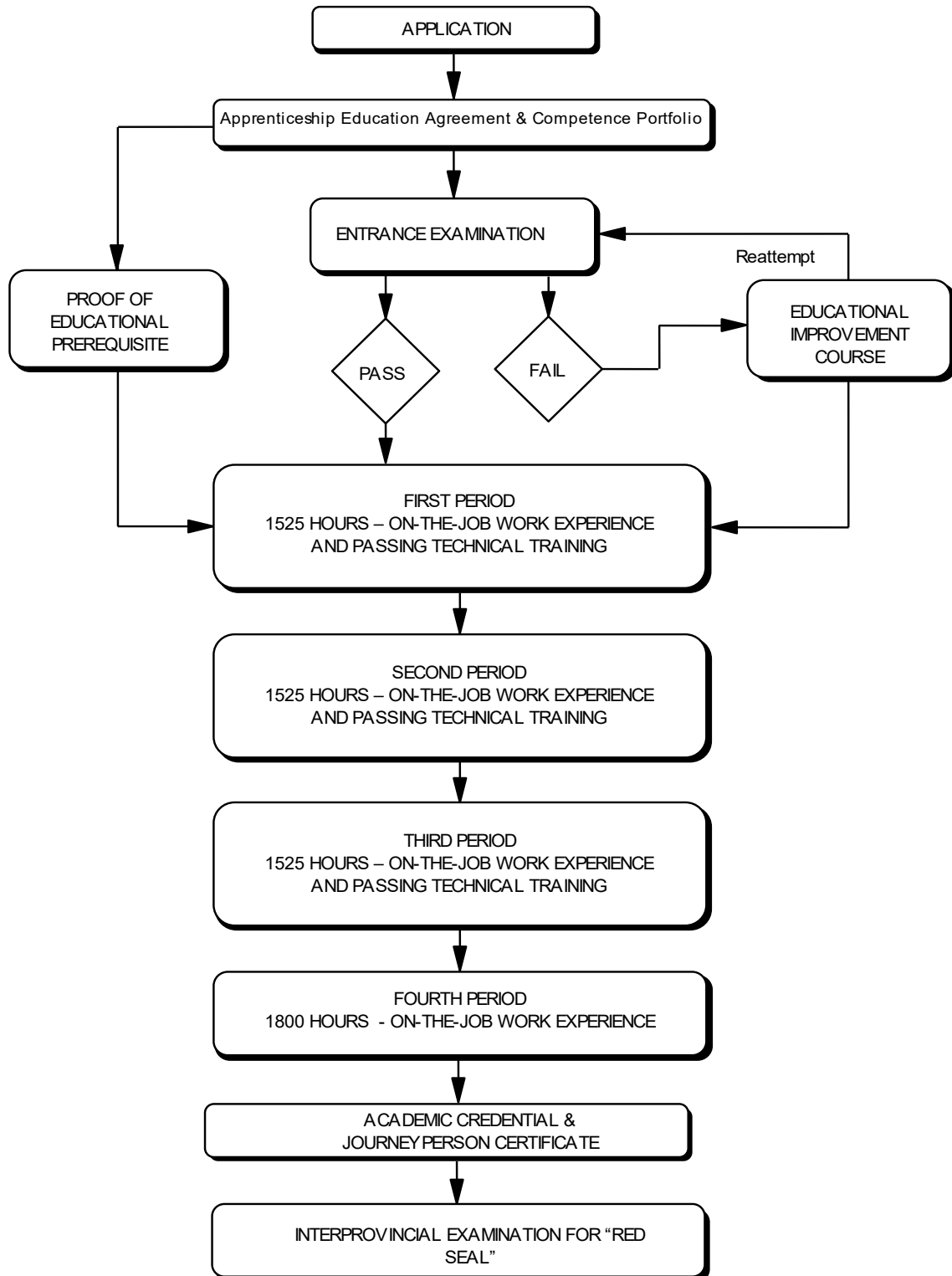
Procedures for Recommending Revisions to the Curriculum Guide

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

- Registrar of Apprenticeship Programs
- c/o Apprenticeship Delivery and Industry Support Services
- Apprenticeship Delivery and Industry Support
- Advanced Education
- 19th floor, Commerce Place
- 10155 102 Street NW
- Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used.

Apprenticeship Route toward Academic Credential



**Powerline Technician Training Profile
FIRST PERIOD
(7 Weeks 30 Hours per Week – Total of 210 Hours)**

SECTION ONE

STANDARD WORKPLACE SAFETY AND CODES 14%	A	B	C
	Safety Legislation, Regulations & Industry Policy in the Trade 14%	Climbing, Lifting, Rigging and Hoisting 11%	Hazardous Materials & Fire Protection 11%
	D	E	F
	Personal Protective Equipment and Arc Flash 21%	Introduction to Personal Protective Grounding 14%	Introduction to Apprenticeship 7%
	G		
	AEUC Section 0,2 and 4 22%		

SECTION TWO

INTRODUCTION TO ELECTRICAL THEORY 23%	A	B	C
	Trade Mathematics 8%	Electrical Fundamentals 9%	Series Resistive Circuits 12%
	D	E	F
	Parallel Resistive Circuits 12%	Series-Parallel Resistive Circuits 12%	Power, Line Loss, and Voltage Drop 10%
	G	H	I
Edison Three Wire Distribution Systems 15%	Electromotive Force 10%	Phasors 12%	

SECTION THREE

INTRODUCTION TO TRANSFORMER THEORY 17%	A	B	C
	Magnetism 14%	Transformer Basics 15%	Transformer Operation 14%
	D	E	F
	Transformer Ratings 14%	Transformer Windings and Tap Changers 15%	Transformer Installation 14%
	G		
Transformer Cooling and Dielectric 14%			

SECTION FOUR

OVERHEAD LINE CONSTRUCTION
33%



A Powerline Poles 7%	B Pole Setting and Climbing Safety 9%	C Insulators 7%
D Anchors and Guys 6%	E Conductors 8%	F Conductors Stringing 7%
G Splicing and Terminating 9%	H Trade Tools and Equipment 8%	I Rigging and Hoisting 9%
J Radial Boom Digger (RBD) Fundamentals 9%	K Load Charts 7%	L Hydraulic Fundamentals 7%
M Hydraulic Systems 7%		

SECTION FIVE

INTRODUCTION TO METERING
13%



A Electrical Measurement Devices 50%	B Single Phase Revenue Metering 50%
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SECOND PERIOD
(7 Weeks 30 Hours per Week – Total of 210 Hours)

SECTION ONE

INTERMEDIATE ELECTRICAL THEORY
 34%



A
 Resistance in AC Circuits
 3%

B
 Inductance and Inductive Reactance
 17%

C
 Capacitance and Capacitive Reactance
 17%

D
 Impedance in Series Resistive-Reactive Circuits
 20%

E
 Impedance in Parallel Resistive-Reactive Circuits
 20%

F
 Single Phase Power and Power Factor
 14%

G
 Basic Three Phase Systems
 9%

SECTION TWO

INTERMEDIATE TRANSFORMER THEORY
 20%



A
 Transformer Applications
 9%

B
 System Grounding
 14%

C
 Transformer Impedance
 24%

D
 Three Phase Transformer Connections
 43%

E
 Three Phase Distribution Transformer Installations
 10%

SECTION THREE

UNDERGROUND LINE CONSTRUCTION AND STREET LIGHTING
 23%



A
 Legal Land Descriptions
 8%

B
 Underground Distribution
 21%

C
 Underground Cable Termination and Splicing
 22%

D
 Underground Distribution Testing and Troubleshooting
 16%

E
 Street Lighting and Relays
 33%

SECTION FOUR

INTERMEDIATE METERING
 13%



A
 Electrical Measuring and Recording and Indicating Devices
 21%

B
 Instrument Transformers
 36%

C
 Instrument Rated Revenue Metering
 43%

SECTION FIVE

UTILITY CODES AND SAFETY
 10%



A
 Personal Protective Grounding
 67%

B
 AEUC Section 6, 10 and 12
 33%

THIRD PERIOD
(7 Weeks 30 Hours per Week – Total of 210 Hours)

SECTION ONE

THREE PHASE ELECTRICAL AND MOTOR THEORY
 22%



A	B	C
Wye Circuits 26%	Delta Circuits 26%	Three Phase Power and Relationship 22%
D	E	
Three Phase Power Factor Correction 17%	Single and Three Phase Motors 9%	

SECTION TWO

TRANSFORMER THEORY
 27%



A	B	C
Transformer Theory 11%	Three Phase Transformer Connections (Part A) 22%	Three Phase Transformer Connections (Part B) 21%
D	E	F
Three Phase Transformer Banks 14%	CSP Transformers 5%	Voltage Regulators 14%
G		
Voltage Regulator Service 13%		

SECTION THREE

LINE CONSTRUCTION THEORY
 20%



A	B	C
Sagging Conductors 24%	Underground Distribution 14%	Insulation Testing 14%
D		
Circuits—Protection and Switching 48%		

SECTION FOUR

METERING
 20%



A	B	C
Phasing and Phase Rotation 14%	Meter Installation and Operation 28%	Instrument Rated (IR) Energy/ Demand Meters 48%
D		
Meter Seals and Energy Diversion 10%		

SECTION FIVE

SAFETY
 11%



A	B	C
Safety and Utility Regulations 38%	Proper Communications 29%	Workplace Coaching Skills 16%
D		
Interprovincial Standards Red Seal Program 17%		

**FIRST PERIOD TECHNICAL TRAINING
POWERLINE TECHNICIAN TRADE
CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: STANDARD WORKPLACE SAFETY AND CODES..... 14%

A. Safety Legislation, Regulations & Industry Policy in the Trade..... 14%

Outcome: *Apply legislation, regulations and practices ensuring safe work in this trade.*

1. Demonstrate the application of the Occupational Health and Safety Act, Regulation and Code.
2. Describe the sponsor's and employee's role with Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations and related advisory bodies and agencies.
3. Describe industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and sponsors to apply emergency procedures.
5. Describe tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of sponsors and employees with the selection and use of personal protective equipment (PPE).
7. Maintain required PPE for tasks.
8. Use required PPE for tasks.

B. Climbing, Lifting, Rigging and Hoisting..... 11%

Outcome: *Use industry standard practices for climbing, lifting, rigging and hoisting in this trade.*

1. Describe manual lifting procedures.
2. Describe rigging hardware and associated safety factors.
3. Select equipment for rigging loads.
4. Describe hoisting and load moving procedures.
5. Maintain personal protective equipment (PPE) for climbing, lifting and load moving equipment.
6. Use PPE for climbing, lifting and load moving equipment.

C. Hazardous Materials & Fire Protection 11%

Outcome: *Apply industry standard practices for hazardous materials and fire protection in this trade.*

1. Describe roles, responsibilities, features and practices related to the Workplace Hazardous Materials Information System (WHMIS) program.
2. Describe three key elements of WHMIS.
3. Describe handling, storing and transporting procedures for hazardous material.
4. Describe venting procedures when working with hazardous materials.
5. Describe hazards, classes, procedures and equipment related to fire protection.

D. Personal Protective Equipment and Arc Flash 21%

Outcome: *Describe the inspection, care and maintenance of PPE.*

1. List the inspection and maintenance procedures for lineman's climbing belts and pole straps as per OH&S Code (part 9).
2. Describe the care, maintenance and storage of protective rubber gloves, sleeves, live line tools and live line cover-up.
3. Illustrate the daily inspection of protective rubber gloves, sleeves, live line tools and live line cover-up.
4. Describe the visual and dielectric testing of protective rubber gloves, sleeves, live line tools and live line cover-up.
5. List the types and applications of hot sticks and accessories.
6. Describe the causes and consequences of arc flash.

E. Introduction to Personal Protective Ground 14%

Outcome: *Describe personal protective grounding.*

1. Describe the hazards of current through a human body.
2. Identify the hazards that personal protective grounds guard against.
3. Identify the electrical and mechanical requirements of a personal protective ground.
4. Outline the procedure for installing and removing personal protective grounds.

F. Introduction to Apprenticeship..... 7%

Outcome: *Describe the apprenticeship system.*

1. Describe the apprenticeship system as it relates to apprentices training and responsibilities.
2. Describe the apprenticeship system as it relates to the sponsor's responsibilities in the apprenticeship systems.

G. AEUC Sections 0,2, and 4..... 22%

Outcome: *Apply Alberta Electrical Utility Code (AEUC) as it relates to sections 0, 2 and 4.*

1. Interpret section "0" of the AEUC.
2. Interpret section "2" of the AEUC.
3. Interpret Appendix A section "4" of the AEUC.

SECTION TWO:..... INTRODUCTION TO ELECTRICAL THEORY 23%

A. Trade Mathematics 8%

Outcome: *Solve trade related problems using mathematical skills.*

1. Perform basic math calculations.
2. Define the terms ratio and direct proportion and perform calculations using both.
3. Convert between SI and Imperial units of measurement.
4. Solve linear, area, volume, weight and temperature problems.
5. Transpose simple algebraic equations to solve for one unknown.
6. Solve right angle triangles using trigonometry.

B. Electrical Fundamentals 9%**Outcome: Solve basic electrical problems.**

1. Explain the fundamental relationship between the structure of the atom and the flow of electrons.
2. Explain the units of measurement for basic electrical terms and symbols.
3. Apply Ohm's Law to electrical circuit calculations.
4. Connect circuits to verify the relationships between voltage, current, and resistance.

C. Series Resistive Circuit 12%**Outcome: Analyze a series resistive Circuit**

1. Define a series circuit and calculate current in a series circuit.
2. Explain the formula for total resistance and calculate resistance in a series circuit.
3. Explain Kirchhoff's voltage law as it relates to a series circuit.
4. Explain the relationship between the resistive values of components and their voltage drops and solve problems using the voltage divider rule.
5. Determine the voltage drop across a closed-or-open-circuit component in a series circuit.
6. Connect to verify Kirchhoff's current and voltage laws in a series resistive circuit.

D. Parallel Resistive Circuits 12%**Outcome: Analyze a parallel resistive circuit.**

1. Define a parallel circuit.
2. Explain the formula for total resistance and calculate resistance in a parallel circuit.
3. Explain Kirchhoff's current law as it relates to a parallel circuit.
4. Describe the effects of open or short circuited components in a parallel circuit.
5. Use the current divider principle to calculate branch currents.
6. Connect to verify Kirchhoff's current laws in a parallel resistive circuit.

E. Series-Parallel Resistive Circuit 12%**Outcome: Analyze a basic series-parallel resistive circuit.**

1. Identify series and parallel portions of a simple series-parallel resistive circuit.
2. Calculate the total resistance of a series-parallel circuit.
3. Apply Kirchhoff's current law in a series-parallel circuit.
4. Apply Kirchhoff's voltage law in a series-parallel circuit.
5. Solve problems involving series-parallel circuits.
6. Connect to verify the relationship of current, voltage and resistance in each part of a series/parallel circuit.

F. Power, Line Loss, and Voltage Drop 10%**Outcome: Describe power, energy, line loss, and voltage drop in electrical circuits.**

1. Describe and calculate power and energy.
2. Describe and calculate voltage drop and its effect on circuits as current changes.

3. Describe and calculate line loss.
4. Connect circuits to verify power formulae.

G. Edison Three Wire Distribution Systems..... 15%

Outcome: *Analyze Edison three wire distribution systems and the effects of an open neutral.*

1. Describe a basic three wire distribution system and list its advantages.
2. Solve problems involving balanced and unbalanced three wire distribution.
3. Solve problems involving an open neutral on balanced and unbalanced three wire distribution systems.
4. Verify the effects of an open neutral on three wire distribution systems.

H. Electromotive Force..... 10%

Outcome: *Explain Electromotive Force.*

1. Define Electromotive Force (EMF).
2. Describe the production of EMF using chemicals, heat, light, and pressure.
3. Describe the connection of batteries in series and in parallel.
4. Describe the production of EMF using magnetism.
5. Describe standard ac sine wave values including instantaneous, RMS, and maximum.
6. Describe the relationship between cycles, poles, and frequency.
7. State nominal voltages used on utility systems.

I. Phasors..... 12%

Outcome: *Solve single phase phasor problems.*

1. Explain phasors and vectors.
2. Describe leading and lagging phasors.
3. Perform phasor addition using rectangular and polar calculations.

SECTION THREE:.....INTRODUCTION TO TRANSFORMER THEORY..... 17%

A. Magnetism..... 14%

Outcome: *Explain the principles of magnetism, electromagnetism, and electromagnetic induction.*

1. Describe the properties of magnetic materials.
2. Define the terminology related to magnetism.
3. Describe electromagnetism and basic design considerations for electromagnetic devices.
4. Describe the process of electromagnetic induction.

B. Transformer Basics..... 15%

Outcome: *Explain the construction and identification of transformers.*

1. Describe the purposes and applications of transformers.
2. List the basic components and the nameplate information of a transformer.

3. Explain the standard terminal and winding identification.
4. Identify the primary and secondary terminals of a transformer and differentiate between step up and step down.

C. Transformer Operation 14%

Outcome: *Explain the operation and loading of transformers.*

1. Describe the operation of a transformer at no load (excitation).
2. Describe the operation of a transformer as load is added.
3. List the losses that occur in a transformer.
4. State why utilities may accept 100% efficiency for transformer calculations.

D. Transformer Ratings 14%

Outcome: *Explain transformer voltage ratings.*

1. State how transformers are rated and typically manufactured.
2. Solve problems involving transformer voltage, turns, and current ratios.
3. Describe the possible effects of operating a transformer at greater than rated voltage.
4. Calculate the rated primary and secondary currents of a transformer from nameplate data.
5. Select a properly rated transformer for a specified load.
6. Connect to verify transformer voltage, turns, and current ratios.

E. Transformer Windings and Tap Changers 15%

Outcome: *Explain transformer windings and tap changers.*

1. Differentiate between additive and subtractive polarity.
2. Explain why tap changers are used.
3. Explain how to set a tap changer to increase or decrease secondary voltage levels.
4. Determine the approximate voltage change when taps are changed to various steps.
5. Describe the steps required to safely change the tap setting on a tap changer.
6. Connect multi-winding transformers for series or parallel operation and calculate primary and secondary voltage levels.

F. Transformer Installation 14%

Outcome: *Explain the installation of distribution transformers.*

1. List the items to be checked prior to installing a transformer.
2. Select the size of fuse from a fuse chart for a given transformer.
3. Describe the connection of a lightning arrester.
4. Define the causes of backfeed, hazards involved, and how to avoid them.
5. Explain the grounding of a single phase secondary service.
6. Identify the hazards of improper grounding.

G. Transformer Cooling and Dielectric 14%**Outcome: Explain transformer cooling methods and dielectric oil.**

1. Describe the various methods of cooling of transformers.
2. Identify the hazards of PCBs as related to transformer oils.
3. Describe how impurities in oil affect its dielectric strength.
4. Describe how to take an oil sample and how it is tested.

SECTION FOUR:..... OVERHEAD LINE CONSTRUCTION 33%**A. Power Line Poles..... 7%****Outcome: Explain powerline structures and their handling.**

1. Describe the types of powerline structures.
2. Describe the treatments used for powerline poles.
3. Define the differences between classes of wood poles.
4. Identify the information found on pole stamps.
5. Describe basic framing and attachments to wood poles.
6. Describe the procedures for loading, hauling and unloading of poles.

B. Pole Setting and Climbing Safety 9%**Outcome: Explain pole installation and climbing.**

1. Describe the forces exerted on power line structures.
2. Identify the standardized markings that are used in Alberta to mark location of underground facilities.
3. List the hazards involved in power digging and how to minimize these hazards.
4. Describe methods of setting poles.
5. Determine when pole cover up and rubber gloves are required to be used when setting poles.
6. Describe the factors that affect how poles are faced in various situations.
7. Describe problems caused when poles are improperly backfilled and tamped.
8. Explain the hazards involved in climbing poles.

C. Insulators 7%**Outcome: Explain the characteristics of insulators used in powerline construction.**

1. List the common types of insulator materials used on power systems.
2. Describe the different type of insulators and their applications.
3. Define B.I.L. (basic impulse level) rating of power system insulators.
4. Define flashover and leakage current.
5. Define dielectric strength of insulating materials.
6. Identify typical causes of insulator failure.
7. List common causes and methods of prevention of radio/TV interference.

D. Anchors and Guys 6%**Outcome: Explain the application of anchors and guys used in powerline construction.**

1. Describe the types and holding capacities of powerline anchors.
2. Describe the proper installation of typical anchor types.
3. Describe the proper placement of anchors and state reasons for anchor failure.
4. Calculate guy tensions.

E. Conductors 8%**Outcome: Describe the type of conductors used in powerline construction.**

1. Describe the advantages and disadvantages of various types of material used for line conductors.
2. Recognize conductor sizes with the use of American Wire Gauge (AWG).
3. Explain the relationship between the size and ampacity of conductors.
4. Describe common aerial conductor types.

F. Conductor Stringing 7%**Outcome: Explain methods of stringing and recovering powerlines.**

1. Describe common methods of handling and storage of reels of conductor.
2. Describe common methods of stringing and recovering power line conductors.
3. Describe the fundamental relationship between tension and sag.
4. Describe the methods used for conductor tie-in.

G. Splicing and Terminating 9%**Outcome: Explain how to splice, connect and terminate overhead conductors.**

1. Describe the use of manual and power driven presses.
2. Describe how to check for proper compression.
3. Describe the preparation of conductors for splicing and deadending.
4. Identify the proper conductor splicing sleeves and press dies using reference charts (include automatic type splices).
5. Identify the proper insulated sleeve for low voltage conductor splicing from reference charts.
6. Demonstrate manufacturer's operating and maintenance practices for explosive actuated tools.

H. Trade Tools and Equipment 8%**Outcome: Explain the inspection, care, and maintenance of tools.**

1. Describe the selection, use and operation of basic line construction tools.
2. Describe the sharpening of climber gaffs.
3. Describe care, maintenance and safety precautions for power and hand tools.

I. Rigging and Hoisting 9%**Outcome: Explain rigging and hoisting practices.**

1. Identify types and ratings of synthetic rope.
2. Describe the causes and effects of shock loading on rigging.
3. Explain how to reeve a set of multiple rope blocks.
4. Demonstrate how to reeve a set of multiple rope blocks.
5. Calculate the mechanical advantage of rope blocks.
6. Demonstrate common knots and hitches on rope.
7. Estimating load weights for rigging and hoisting purposes.

J. Radial Boom Digger (RBD) Fundamentals 9%**Outcome: Explain hoisting and operating principles of a RBD.**

1. Demonstrate knowledge of crane and hoisting signals.
2. Explain the importance of crew communications when operating load handling equipment.
3. Identify the inspection and maintenance of a RBD.
4. Describe the hazards and procedures for the inspection, setup and use for a RBD.
5. Explain the operating characteristics.

K. Load Charts..... 7%**Outcome: Interpret load charts.**

1. Explain the purpose of load charts.
2. Describe the effect of quadrants of operation on capacity.
3. Explain how capacities are affected by attachments.
4. Explain how capacities are affected by the location of the load in relationship to the unit.
5. Explain how capacities are affected by setup.

L. Hydraulic Fundamentals..... 7%**Outcome: Explain fundamental hydraulic principles.**

1. Apply Pascal's Law.
2. Describe the operation of a hydraulic cylinder.
3. Describe the operation of a control valve.
4. Describe the operation of a hydraulic pump.
5. Describe the operation of a hydraulic motor.

M. Hydraulic Systems 7%**Outcome: Explain the hydraulic systems on RBD's.**

1. Identify the components.
2. Explain the functions of components.
3. Explain the hydraulic flow through a system.
4. Identify how the environment affects hydraulic systems.

SECTION FIVE:..... INTRODUCTION TO METERING 13%

A. Electrical Measurement Devices 50%

Outcome: *Demonstrate the use of electrical measuring devices.*

1. Describe the care, connections and safety precautions for common electrical measuring devices
2. Demonstrate accurate measurements using common electrical measuring devices.
3. Demonstrate range selection and wiring connections for common electrical measuring devices.

B. Single Phase Revenue Metering 50%

Outcome: *Verify operation of single phase self-contained revenue metering.*

1. Describe the basic operation of a kWhr meter.
2. Read a single-phase meters (energy and demand).
3. Verify socket connections prior to changing or installing a new meter.
4. Explain what a clock-over and a complete clock-over are.
5. Connect to verify correct operation of a single phase three wire energy meter.

**SECOND PERIOD TECHNICAL TRAINING
POWERLINE TECHNICIAN TRADE
CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:.....INTERMEDIATE ELECTRICAL THEORY 34%

A. Resistance in ac Circuits 3%

Outcome: *Explain how resistors affect an ac circuit.*

1. Analyze an ac circuit containing resistors connected in series.
2. Analyze an ac circuit containing resistors connected in parallel.

B. Inductance and Inductive Reactance..... 17%

Outcome: *Explain the effects of inductance on ac and dc circuits.*

1. Describe a basic inductor (coil).
2. Describe inductance and the factors which affect it.
3. Describe induction and its effects.
4. Describe the effects of an inductor in a dc circuit.
5. Describe the effects of an inductor in an ac circuit.
6. Analyze an ac inductive circuit.
7. Describe the power relationships in an ac inductive circuit.
8. Connect to verify ac circuits containing inductance.

C. Capacitance and Capacitive Reactance 17%

Outcome: *Explain the effects of capacitance on ac and dc circuits.*

1. Describe the construction of a basic capacitor.
2. Describe capacitance and the factors which affect it.
3. Describe the effects of a capacitor in a dc circuit.
4. Describe the effects of a capacitor in an ac circuit.
5. Analyze an ac capacitive circuit.
6. Describe the power relationships in an ac capacitive circuit.
7. Explain the hazards of refusing capacitors.
8. Connect to verify ac circuits containing capacitance reactance.

D. Impedance in Series Resistive-Reactive Circuits..... 20%

Outcome: *Explain impedance in series resistive reactive circuits.*

1. Describe impedance in a series RL circuit.
2. Describe impedance diagrams and their relationship to phasor diagrams and power diagrams in series circuits.
3. Explain power factor and phase angle.

4. Describe impedance for series RC circuits.
5. Describe series RLC circuits and the hazards associated with them.
6. Connect to verify series resistive–reactive circuits.

E. Impedance in Parallel Resistive-Reactive Circuits..... 20%

Outcome: Analyze parallel resistive reactive circuits.

1. Describe impedance in a parallel RL circuit.
2. Describe impedance diagrams and their relationship to phasor diagrams and power diagrams in parallel circuits.
3. Explain parallel RL circuits.
4. Explain parallel RC circuits.
5. Explain parallel RLC circuits.
6. Connect to verify parallel resistive-reactive circuits.

F. Single Phase Power and Power Factor 14%

Outcome: Explain power and power factor.

1. Define true, apparent and reactive power.
2. Connect to verify true, apparent and reactive power.
3. Define power factor.
4. Describe the reasons for correcting power factor.
5. Solve power factor correction calculations.
6. Connect to verify power factor correction.

G. Basic Three Phase Systems 9%

Outcome: Explain basic three phase systems.

1. Describe basic three phase generation of voltages.
2. Describe wye connected loads and sources.
3. Describe delta connected loads and sources.

SECTION TWO:..... INTERMEDIATE TRANSFORMER THEORY..... 20%

A. Transformer Applications 9%

Outcome: Explain transformers applications on power systems.

1. Describe the application of transformers in network distribution situations.
2. Describe the application of transformers in substation power situations.
3. Describe the application of transformers in general distribution situations.

B. System Grounding 14%

Outcome: Explain system grounding.

1. Describe the purpose of a system ground.
2. Describe the differences between neutral return systems and earth return systems.

3. Describe the hazards of an open neutral or an open ground connection.
4. Describe the function of a ground rod as an electrical connection.
5. Determine ground resistance by means of an earth resistance tester.

C. Transformer Impedance 24%

Outcome: *Explain transformer impedance and paralleling of transformers.*

1. Define percent impedance (%IZ).
2. Determine maximum secondary fault current using transformer nameplate information.
3. Describe the requirements for paralleling two single phase transformers.
4. Connect to verify the % IZ of a transformer.
5. Connect to verify how two single phase transformers in parallel share load.

D. Three Phase Transformer Connection 43%

Outcome: *Determine the voltage relationships for standard three phase transformer connections.*

1. Describe the voltage characteristics of standard three phase transformer connections.
2. Draw standard three phase transformer connections.
3. Connect to verify voltages of standard three phase transformer connections.

E. Three Phase Distribution Transformer Installation 10%

Outcome: *Explain pre-installation requirements of transformers in a bank.*

1. Determine the transformer connection by interpreting nameplate data.
2. Describe the possible internal winding connections that may be required before hanging transformers in a bank.
3. Determine fusing requirements for standard three phase transformer connections.
4. Describe the hazards of backfeeds and energized potentials from transformer banks.
5. Determine customer loading allowed for open wye and open delta connections.

SECTION THREE: UNDERGROUND LINE CONSTRUCTION AND STREET LIGHTING 23%

A. Legal Land Descriptions 8%

Outcome: *Explain the use of legal land descriptions in Alberta.*

1. Describe the legal land description systems.
2. Locate a legal land description on a map.
3. Identify the legal land description of a location on a map.

B. Underground Distribution 21%

Outcome: *Explain underground distribution systems.*

1. Describe the advantages and disadvantages of underground distribution systems.
2. Identify associated components of underground systems.
3. Describe loop, radial and network systems.

4. Describe direct burial and ductwork installation of underground cable.
5. Explain the appropriate codes to be followed with installation.

C. Underground Cable Termination and Splicing 22%

Outcome: *Explain methods used to terminate and splice underground cables.*

1. Describe commonly used primary and secondary cables.
2. Describe the components and purpose of primary and secondary underground cables.
3. Describe the components and purpose of a high voltage termination.
4. Describe methods used to terminate and splice primary and secondary cables.
5. Identify a load break and a non-load break elbow.

D. Underground Distribution Testing and Troubleshooting 16%

Outcome: *Explain testing and fault locating.*

1. Explain the purpose of single line diagrams used for troubleshooting.
2. Verify proper system operation.
3. Interpret the operation of fault indicators.
4. Describe cable testing and fault locating methods.

E. Street Lighting and Relays..... 33%

Outcome: *Explain street lighting systems.*

1. Describe the installation of street lighting components.
2. Describe operating characteristics of lamps used in street lighting.
3. Describe operating characteristics and connections of lamp ballasts.
4. Describe the disposal methods of lamps and ballasts.
5. Describe the operation of relays and photoelectric eyes.
6. Demonstrate relay operation.
7. Demonstrate street light circuits.

SECTION FOUR:INTERMEDIATE METERING 13%

A. Electrical Measuring, Recording, and Indicating Devices 21%

Outcome: *Explain the purpose of electrical measuring, recording, and indicating devices.*

1. Describe the purpose for the use recording devices.
2. Describe the purpose for the use measuring devices.
3. Describe the purpose for the use indicating devices.

B. Instrument Transformers 36%

Outcome: *Explain the applications of instrument transformers.*

1. Describe the function and ratings of potential transformers and their hazards.
2. Describe the function and ratings of current transformers and their hazards.
3. Explain primary and secondary fusing of potential transformers.

4. Explain current transformer grounding and shorting.
5. Connect to verify instrument transformer ratios.

C. Instrument Rated Revenue Metering 43%

Outcome: *Explain the operation and connections of single phase instrument type revenue metering.*

1. Describe the operation of an instrument rated revenue meter.
2. Calculate a load through a meter using kh.
3. Connect to verify the load on an energy meter.

SECTION FIVE:UTILITY CODES AND SAFETY..... 10%

A. Personal Protective Grounding 67%

Outcome: *Explain methods of grounding for personal protection.*

1. Describe how personal protective grounding minimizes electrical hazards.
2. Describe step and touch potential and state how fault current varies with proximity to sources of fault current.
3. Describe the factors affecting resistance of ground electrode connections and reasons for keeping temporary ground rods away from the base of poles.
4. Explain the principles of equal-potential bonding and grounding.
5. Describe the sequence to be followed when installing or removing protective grounds.

B. AEUC Section 6, 10 and 12 33%

Outcome: *Apply Electrical Utility Code (AEUC) as it relates to sections 6, 10 and 12.*

1. Interpret section "6" of the AEUC.
2. Interpret section "10" of the AEUC.
3. Interpret section "12" of the AEUC.
4. Interpret Appendix A section "4" of the AEUC.
5. Interpret Appendix C of the AEUC.
6. Interpret Appendix D of the AEUC.

**THIRD PERIOD TECHNICAL TRAINING
POWERLINE TECHNICIAN TRADE
CURRICULUM GUIDE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... THREE PHASE ELECTRICAL AND MOTOR THEORY 22%

A. Wye Circuits 26%

Outcome: Analyze balanced and unbalanced wye circuits using phasor diagrams.

1. Identify the relationship between line and phase current.
2. Identify the relationship between line and phase voltage.
3. Explain the function of the neutral conductor.
4. Explain the relationships between current and voltages in unity and non-unity power factors.
5. Connect to verify the relationships between voltage and current in unity and non-unity power factors.

B. Delta Circuits 26%

Outcome: Analyze balanced and unbalanced delta circuits using phasor diagrams.

1. Identify the relationship between line and phase current.
2. Identify the relationship between line and phase voltage.
3. Explain the relationships between current and voltages in unity and non-unity power factors.
4. Connect to verify the relationships between voltage and current in unity and non-unity power factors.

C. Three Phase Power Relationships 22%

Outcome: Describe three phase power in balanced and unbalanced systems.

1. Define true, apparent and reactive power.
2. Calculate true, reactive, and apparent power.
3. Connect to verify true, apparent and reactive power.

D. Three Phase Power Factor Correction 17%

Outcome: Explain three phase power factor correction in balanced and unbalanced systems.

1. Define power factor.
2. Describe the reasons for correcting power factor.
3. Solve power factor correction calculations.
4. Connect to verify power factor correction.

E. Single and Three Phase Motors 9%

Outcome: Compare the operation characteristics of single and three phase motors.

1. Compare single phase motors to three phase motors.
2. Describe the method used to reverse motors.
3. Describe the effects of an open phase on a three phase motor under starting and under running conditions.
4. Describe the effects of over and under voltage on motors.
5. Describe the effects on a utility system of full voltage starting large motors.
6. Describe the effects of voltage unbalance on a three phase motor.
7. Connect to verify single phase motor operation.
8. Connect to verify three phase motor operation.

SECTION TWO:..... TRANSFORMER THEORY 27%

A. Transformer Theory 11%

Outcome: Describe transformer operations.

1. Transformer ratings and ratios.
2. Transformer winding characteristics and terminology.
3. Transformer impedance and paralleling single phase transformers.

B. Three Phase Transformer Connections (Part A) 22%

Outcome: Describe the voltage and current relationships and fusing requirements for standard three phase transformer connections.

1. Determine the connection and fusing for a wye/wye transformer bank.
2. Determine the connection and fusing for a delta/delta transformer bank.
3. Determine the connection and fusing for a wye/delta transformer bank.
4. Determine the connection and fusing for a delta/wye transformer bank.

C. Three Phase Transformer Connections (Part B) 21%

Outcome: Determine the voltage and current relationships and fusing requirements for standard three phase transformer connections.

1. Determine the connection and fusing for an open delta/open delta transformer bank.
2. Determine the connection and fusing for an open wye/open delta transformer bank.
3. Determine the connection and fusing for a delta/four wire delta transformer bank.
4. Determine the connection and fusing for a crowfoot transformer bank.

D. Three Phase Transformer Banks 14%

Outcome: Explain considerations when altering a three phase transformer bank.

1. Define causes of backfeed, the hazards involved, and how to avoid it.
2. Determine the rated phase and line currents for a given three phase transformer bank.
3. Describe the requirements for paralleling three phase transformer banks.

4. Define ferro-resonance and describe how to minimize or eliminate its effects.
5. Perform alterations on a three phase transformer bank maintaining the same phase sequence and position of the high leg as prior to the work being performed.

E. CSP Transformers 5%

Outcome: Describe completely self protected (CSP) transformers.

1. Explain the differences between CSP transformers and standard distribution transformers.
2. List the applications and advantages of CSP transformers.

F. Voltage Regulators 14%

Outcome: Describe operation of voltage regulating equipment.

1. Describe voltage regulation and why it is required.
2. Differentiate between on-load and off-load tap changers and state at least one utility application for each.
3. Interpret the nameplate data on voltage regulating equipment.
4. Explain the effect of the buck or boost winding on the output voltage with the use of a schematic.
5. Describe, in general terms, the operation of a step regulator control unit, making reference to:
 - a) basic voltage setting
 - b) band width setting
 - c) delay timer
 - d) buck boost selector switch

G. Voltage Regulator Service 13%

Outcome: Explain pre-commissioning of voltage regulating equipment.

1. Explain the precaution necessary when paralleling lines or feeders supplied from different voltage regulators.
2. Describe in detail, how to bypass voltage regulating equipment and how to return it to service, using sequenced and non-sequenced bypass switches.
3. Explain the effects on customer voltage if the regulator source and load connections are interchanged.
4. Explain the hazards of touch potential near voltage regulator controls, and how they may be reduced.
5. Describe typical pre-commissioning checks on voltage regulating equipment.

SECTION THREE: LINE CONSTRUCTION THEORY 20%

A. Sagging Conductors..... 24%

Outcome: Explain the requirements and methods of sagging for overhead conductors.

1. Explain the effects on a line if the sagging is either too tight or too loose.
2. Choose the appropriate sag chart, given the necessary line and conductor information (initial or final).
3. Determine the correct sag from charts given the necessary information.
4. Explain in detail the line and sight method of sagging.

5. Explain in general terms other methods of sagging.
6. Explain methods of determining sag on an existing energized line.
7. Explain the effect on sag when changing span length.
8. Explain ruling span and actual (sagging) span.

B. Underground Distribution 14%

Outcome: *Explain the requirements for the identification, mapping and switching of new underground installations.*

1. Verify a single line diagram (S.L.D.) as built, identify cables and return construction guarantee of isolation (GOI) (clearance or permit).
2. Prepare a switching program to energize a new section of an underground system given a single line diagram.

C. Insulation Testing 14%

Outcome: *Explain insulation testing.*

1. State the reasons for insulation testing.
2. Describe the components of current resulting from high potential testing.
3. Explain the term high potential testing and the hazards involved.

D. Circuits – Protection and Switching 48%

Outcome: *Explain operation of circuit protection and switching equipment.*

1. Define the terms fault and short circuit current.
2. Explain how kVA and % IZ affect fault current.
3. Explain the purpose and basic operation of:
 - a) fuses
 - b) sectionalizers
 - c) circuit reclosers
 - d) arrestors
 - e) relays operating a circuit breaker.
4. Explain how the time of operation varies with the magnitude of current.
5. Explain what it means to co-ordinate fuses, sectionalizers and circuit reclosers.
6. Explain the switching hazards and basic operation of the following:
 - a) hot line jumpers
 - b) fused disconnects
 - c) solid blade disconnects and gang operated switches
 - d) sectionalizers and circuit reclosers.
7. Identify common ANSI / IEEE device numbers from single line drawings.

SECTION FOUR: METERING 20%

A. Phasing and Phase Rotation 14%

Outcome: *Demonstrate the use of electrical phasing and phase rotation indicating devices.*

1. Determine the phase sequence of a colour coded or otherwise identified three-phase system with the use of a phase sequence indicator.

2. Relate the hazards involved when using phasing sticks.
3. Demonstrate how to verify proper operation of phasing sticks by cross phasing.
4. Phase-in two three-phase lines with the use of phasing sticks.

B. Meter Installation and Operation 28%

Outcome: *Explain the installation requirements for polyphase “S” base meters.*

1. Explain under what conditions a meter must be installed on the load side of a customer’s disconnecting means.
2. Explain the proper mounting height for self contained meters.
3. Explain where and why a network meter is used.
4. Identify the correct phase colour codes and the correct phasing for polyphase meter sockets.
5. Identify a service with a high leg using a voltmeter.
6. Describe the operation and connection of the following meters:
 - a) network meter “S” base
 - b) three phase four wire wye “S” base
 - c) three phase four wire delta “S” base
7. Verify socket connections and make necessary checks on the meter prior to change or new installation of the meters stated above.
8. Determine the load seen by a meter using Kh for balanced and unbalanced loads.
9. Verify the load ‘seen by’ a meter using a load check (current and voltage) for balanced and unbalanced loads.
10. Determine the actual consumption using the internal multiplier and the meter register readings.

C. Instrument Rated (IR) Energy/Demand Meters 48%

Outcome: *Explain the operation and connection of an instrument rated meter.*

1. Explain the operation of an instrument transformer rated meter.
2. Calculate the load on a meter using Kh for balanced and for unbalanced loads.
3. Verify the load ‘seen by’ a meter using a load check (current and voltage) and the meter multiplier for balanced and unbalanced loads.
4. Determine the actual consumption using the meter multiplier and the meter register readings.
5. Explain how burden can affect the accuracy of the instrument transformers.
6. Describe how and why instrument transformer rated meters are to be grounded.
7. Verify the connection of an instrument transformer meter in reference to a wiring diagram.
8. Connect a meter on an instrument transformer rated meter service:
 - a) three phase four wire delta - energy/demand meter
 - b) three phase four wire wye - energy/demand meter
9. Explain the possible hazards and safe use of test switches on an instrument rated meter.
10. Describe the standard Measurement Canada color code wiring between test switches, meter and instrument transformers.
11. Explain the operation of a kVA or kW thermal demand meter.
12. Describe why demand metering is important to a utility and how to reset demand meters.

D. Meter Seals and Energy Diversion 48%

Outcome: *Explain energy diversion and government requirements on re-testing of meters.*

1. Describe indications of external tampering on metering devices.
2. Describe other indications of energy theft.
3. Explain the difference between government and utility sealing on meters.
4. Explain the government requirements on the re-testing of meters.

SECTION FIVE: SAFETY 11%

A. Safety and Utility Regulations 38%

Outcome: *Interpret rules and regulations according to legislated requirements.*

1. Locate and use CSA 22.3 Overhead Systems as it pertains to the construction of overhead systems.
2. Locate and use section 8 of the AEUC as it pertains to the operation of:
 - a) generating stations.
 - b) substations.
 - c) electrical equipment installations.
3. Locate and use section 10 of the AEUC.
4. Identify applicable AEUC rules given a typical work situation.
5. Locate and use CSA 22.3 Overhead Systems rules to determine vertical design clearances above ground.
6. Locate and use CSA 22.3 Underground Systems as it pertains to underground construction.
7. Restate the safe limits of approach from Appendix A sections 4 and 2 in the AEUC.

B. Proper Communications 29%

Outcome: *Develop switching programs for overhead and underground systems.*

1. From a single line diagram, prepare a switching program to isolate and issue a GOI (or permit) on a section of:
 - a) overhead system
 - b) underground system
 - c) combination of both overhead and underground systems

C. Workplace Coaching Skills 16%

Outcome: *Use coaching skills when coaching an apprentice.*

1. Describe the process for coaching an apprentice

D. Interprovincial Standards Red Seal Program 17%

Outcome: *Use Red Seal products to challenge an Interprovincial examination.*

1. Identify Red Seal products used to develop Interprovincial examinations.
2. Use Red Seal products to prepare for an Interprovincial examination.



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