

# Apprenticeship and Industry Training

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## Welder - Wire Process Operator Apprenticeship Course Outline

12-107.2 (2007)

Government  
of Alberta 



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**Wire Process Operator  
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## **Apprenticeship**

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. 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 – usually a college or technical institute.

To become certified journeymen, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Wire Process Operator Provincial Apprenticeship Committee.

The graduate of the Wire Process Operator apprenticeship program is a certified journeyman who will be able to:

- be skillful in the fusing of metals using prescribed welding applications
- have a working knowledge of the welding equipment involved with the various welding procedures
- comprehend drawings
- have a thorough knowledge of metals and welding gases
- recognize defective welds, know the cause, and proper procedure for the repair of the defective area
- have a working knowledge of mathematics calculations pertaining to the trade
- be familiar with the work of other tradespeople in affiliated trades
- perform assigned tasks in accordance with quality and production standards required by industry

### **Apprenticeship and Industry Training System**

#### **Industry-Driven**

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

#### **Alberta Apprenticeship and Industry Training Board**

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education and Technology on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

#### **Industry Committee Network**

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

## Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

## Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
  - standards and requirements for training and certification in their trade
  - courses and examinations in their trade
  - apprenticeship and certification
  - designation of trades and occupations
  - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

## Wire Process Operator PAC Members at the Time of Publication

Mr. I. Furber.....	Edmonton .....	Presiding Officer
Mr. L. Burns.....	Calgary .....	Employer
Mr. T. Stewart.....	Edmonton.....	Employer
Mr. R. Wright .....	Edmonton.....	Employer
Mr. D. Bohle .....	Lethbridge .....	Employer
Mr. R. Golosky.....	Ft.McMurray .....	Employer
Mr. L. Millington .....	Medicine Hat .....	Employer
Mr. L. Kragnes.....	Vermilion .....	Employer
Mr. B. Pruden .....	Edmonton.....	Employee
Mr. P. Gerlinsky.....	Bonnyville.....	Employee
Mr. A. Hindle.....	Calgary .....	Employee
Mr. J. Gras.....	Edmonton.....	Employee
Mr. T. Major .....	Ft. McMurray .....	Employee
Mr. R. Frederiksen .....	Medicine Hat .....	Employee
Mr. M. Moxness.....	Red Deer .....	Employee

## Alberta Government

Alberta Advanced Education and Technology works with industry, employer 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 employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

## Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education and Technology to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

## 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, employers, 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.

## Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

**The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act*.**

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at [www.tradesecrets.gov.ab.ca](http://www.tradesecrets.gov.ab.ca); access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

**Addendum**

As immediate implementation of the board’s safety policy includes common safety learning outcomes and objectives for all course outlines, this trade’s PAC will be inserting these safety outcomes into the main body of their course outline at a later date. In the meantime the addendum below immediately places the safety outcomes and their objectives into this course outline thereby enabling technical training providers to deliver the content of these safety outcomes.

**STANDARD WORKPLACE SAFETY**

**A. Safety Legislation, Regulations & Industry Policy in the Trades .....**

**Outcome:** *Describe legislation, regulations and practices intended to ensure a safe work place in this trade.*

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to 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. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

**B. Climbing, Lifting, Rigging and Hoisting .....**

**Outcome:** *Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.*

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

**C. Hazardous Materials & Fire Protection.....**

**Outcome:** *Describe the safety practices for hazardous materials and fire protection in this trade.*

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

## **Workplace Health and Safety**

A tradesperson is often exposed to more hazards than any other person in the work force 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.

Workplace Health and Safety (Alberta Employment, Immigration and Industry) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at [www.worksafely.org](http://www.worksafely.org)

## **Technical Training**

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Wire Process Operator apprenticeship technical training:  
Red Deer College

## **Procedures for Recommending Revisions to the Course Outline**

Advanced Education and Technology has prepared this course outline in partnership with the Wire Process Operator Provincial Apprenticeship Committee.

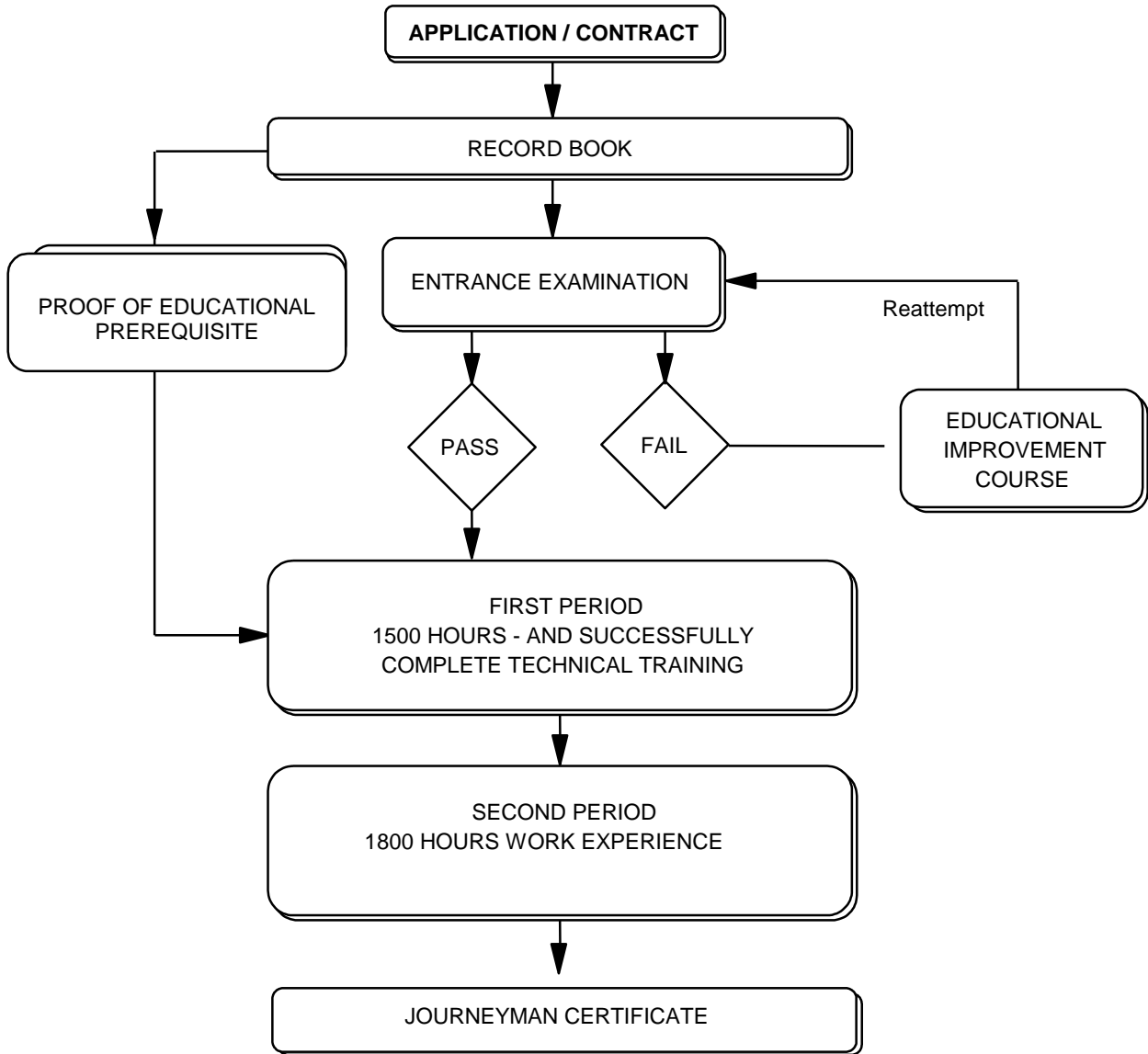
This course outline was approved on December 11, 2006 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

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

Wire Process Operator Provincial Apprenticeship Committee  
c/o Industry Programs and Standards  
Apprenticeship and Industry Training  
Advanced Education and Technology  
10th 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. Recommendations for change will be placed on the agenda for regular meetings of the Wire Process Operator Provincial Apprenticeship Committee.

**Apprenticeship Route toward Certification**



**Wire Process Operator Training Profile  
First Period  
(8 Weeks 30 Hours per Week – Total of 240 Hours)**

**SECTION ONE**

<b>SAFETY, TOOLS, WELD FAULTS AND OAW</b> <b>48 HOURS</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Welder Apprenticeship Program Orientation 120101a 2 Hours	Safety Guidelines 120101b 4 Hours	Welding Safety 120101c 4 Hours
	<b>D</b>	<b>E</b>	<b>F</b>
	Hand Tools 120101d 2 Hours	Power Tools 120101e 5 Hours	Weld Faults 120101f 5 Hours
	<b>G</b>	<b>H</b>	<b>I</b>
	Oxy-fuel Equipment 120101g 4 Hours	Oxy-fuel Cutting 120101i 12 Hours	Materials Handling 120101j 10 Hours

**SECTION TWO**

<b>DRAWINGS, METALS, BASIC JOINTS AND WELDS AND ARC CUTTING AND DISTORTION</b> <b>47 HOURS</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Introduction to Pattern Development 120204a 6 Hours	Production and Properties of Metals 120201b 6 Hours	Basic Joint and Weld Types 120102c 4 Hours
	<b>D</b>	<b>E</b>	<b>F</b>
	Carbon & Alloy Steels and Alloy Steel Filler Metals 120201c 8 Hours	Arc Cutting and Gouging 120102e 3 Hours	Distortion 120201e 3 Hours
	<b>G</b>	<b>H</b>	<b>I</b>
	Hardfacing 120201f 3 Hours	Welding Symbols 120204g 7 Hours	Heat Treatment 120304d 7 Hours

**SECTION THREE**

<b>GMAW, FCAW AND SAW</b> <b>113 HOURS</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Gas Metal Arc Welding (GMAW) - Equipment 120103a 4 Hours	GMAW Filler Metals, Shielding Gases and Safety 120103b 4 Hours	GMAW, Equipment and Troubleshooting 120103c 7 Hours
	<b>D</b>	<b>E</b>	<b>F</b>
	Flux Cored Arc Welding (FCAW) 120103d 4 Hours	Submerged Arc Welding (SAW) 120103e 5 Hours	Shop / Lab Practices: GMAW Welds on Mild Steel 120103f 40 Hours
	<b>G</b>	<b>H</b>	<b>I</b>
	Shop / Lab Practices: FCAW Welds on Mild Steel 120103g 30 Hours	Shop / Lab Practices Combined GMAW and FCAW Welds on Mild Steel 120103h 5 Hours	Aluminum and Aluminum Welding 120202e 4 Hours
	<b>J</b>		
	GMAW Welds on Aluminum 120203a 10 Hours		

**SECTION FOUR**

<b>TRADE MATHEMATICS</b> <b>32 HOURS</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Fractions 120104a 4 Hours	Decimals 120104b 4 Hours	Percentage and Ratios 120104c 6 Hours
	<b>D</b>	<b>E</b>	<b>F</b>
	Geometric Formulas 120104d 11 Hours	Metric and Imperial Measure 120104e 6 Hours	Apprenticeship and Industry Training 1 Hour

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

**FIRST PERIOD TECHNICAL TRAINING  
WIRE PROCESS OPERATOR TRADE  
COURSE OUTLINE**

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

**SECTION ONE:.....SAFETY, TOOLS, WELD FAULTS AND OAW ..... 48 HOURS**

**A. Wire Process Operator Apprenticeship Training Program Orientation (120101a) ..... 2 Hours**

**Outcome:**     ***Describe the responsibilities and opportunities in the welding trade.***

1.     Describe the apprenticeship training system in Alberta.
2.     Identify the training profile of Welding Apprenticeship in Alberta.
3.     Explain the Welder program outline learning outcomes and objectives.
4.     Describe the responsibilities for the Contract of Apprenticeship by the apprentice, employer and Alberta Apprenticeship and Industry Training.
5.     Identify industrial, commercial and construction fields that provide employment opportunities for welders.
6.     Discuss the contents of the apprenticeship training Record Book.
7.     Demonstrate the ability to complete an acceptable resume.

**B. Safety Guidelines (120101b)..... 4 Hours**

**Outcome:**     ***Follow O H & S and WHMIS guidelines.***

1.     Describe applications of the Workers' Compensation Act in the work place.
2.     Demonstrate an ability to locate and interpret sections of the Occupational Health and Safety Act, General Safety Regulations as they apply to welding.
3.     Explain the WHMIS program.
4.     Describe the procedure for welding or cutting in confined spaces or on potentially dangerous enclosures.

**C. Welding Safety (120101c) ..... 4 Hours**

**Outcome:**     ***Apply safe work practices and procedures when using welding and cutting equipment.***

1.     Identify physical hazards that are common to welding and cutting equipment.
2.     Identify use of personal protective equipment for welding and cutting operations.
3.     Identify fire hazards and methods of fire.
4.     Explain the hazards involved with welding fumes and gases.
5.     Identify welding fume ventilation methods.
6.     Identify use of personal protective equipment for hazardous and toxic materials.
7.     Explain the effects of electricity and precautions used to prevent injury.

- D. Hand Tools (120101d) ..... 2 Hours**
- Outcome: Use hand tools.**
1. Describe safety precautions for hand tools.
  2. Identify the layout and measuring tools and their uses.
  3. Identify clamping tools and their uses.
  4. Identify cutting tools and their uses.
  5. Identify the other hand tools used by welders.
- E. Power Tools (120101e)..... 5 Hours**
- Outcome: Use power tools.**
1. Describe and demonstrate the safe operation of bench and pedestal grinders, angle and straight grinders.
  2. Describe and demonstrate the use and safe operation of portable power drills, drill presses and twist drills.
  3. Describe the use and safe operation of metal forming, and shaping tools.
  4. Identify and describe the procedures for cutting metals using shearing machines, power cut-off saws, and metal-cutting band saws.
- F. Weld Faults (120101f)..... 5 Hours**
- Outcome: Identify the cause of faults in welds and methods for their prevention.**
1. Define the major classifications of weld faults.
  2. Define notching effect.
  3. Identify basic weld faults, their causes, and ways to avoid them.
- G. Oxy-fuel Equipment (120101g)..... 4 Hours**
- Outcome: Assemble oxy-fuel equipment.**
1. Describe the characteristics and handling procedures for oxygen and fuel gases.
  2. Describe the functions of oxy-fuel equipment components.
  3. Describe the use, care and maintenance of oxy-fuel equipment components.
  4. Explain the recommended procedure for placement, set-up and shutting down the equipment.
  5. Identify causes and preventive measures for backfires, flashbacks and burn backs.
  6. Describe pressure and flame adjustments.
- H. Oxy-Fuel Cutting (120101i)..... 12 Hours**
- Outcome: Perform oxy-fuel cutting.**
1. Demonstrate the ability to safely operate a hand-held oxy-fuel cutting torch on available plate and structural shapes.
  2. Perform straight line, bevel, and cutting on available mild steel.
  3. Pierce and cut holes in mild steel plate.
  4. Cope 3/8" mild steel plate to fit a 4" channel member.
  5. Demonstrate the ability to safely operate an oxy-fuel cutting machine torch on available plate.

**I. Materials Handling (120101j) ..... 10 Hours**

**Outcome: Apply safe materials handling procedures.**

1. Identify safe procedures for handling and storing materials.
2. Determine weight and centre of gravity of loads.
3. Describe the effect that sling angles have on safe lifting.
4. Be able to identify the load limits of commonly used wire rope and synthetic slings.
5. Describe the causes and effects of shock loading on rigging.
6. Identify Occupational Health and Safety Regulations regarding safety factors.
7. Identify and use hand signals for crane operations.
8. Describe safe procedures for lifting, hoisting or moving loads.
9. Describe the care and use of wire rope, synthetic rope and chains.
10. Describe the correct use of plate clamps.
11. Describe the correct procedure for applying wire rope clips.

**SECTION TWO:.....DRAWINGS, METALS, BASIC JOINTS AND WELDS ..... 47 HOURS  
AND ARC CUTTING AND DISTORTION**

**A. Introduction to Pattern Development (120204a)..... 6 Hours**

**Outcome: Identify lines, drawings and drawing equipment.**

1. Identify and use the alphabet of lines.
2. Describe the principles of scale drawings.
3. Identify perspective, oblique and isometric drawings.
4. Describe the principles of oblique and isometric drawings.
5. Describe the principles of orthographic projection:
  - a) interpret the six views of orthographic projection
  - b) identify and describe the three most common views
  - c) describe the principle of sectioning
  - d) describe auxiliary views
6. Sketch simple objects in orthographic projection.
7. Identify SI metric and imperial dimensioning.
8. Describe size, location and notation dimensions:
  - a) aligned
  - b) unidirectional
  - c) base line / datum line
  - d) angular
  - e) curved surfaces
  - f) tolerance
9. Develop a fully dimensioned orthographic drawing to scale.

**B. Production and Properties of Metals (120201b)..... 6 Hours**

**Outcome:** *Identify the production processes and types of iron and steel.  
Identify the mechanical and physical properties of metals.*

1. Describe the production processes for iron and steel.
2. Describe the types of iron and steel.
3. Describe the mechanical properties of metals.
4. Describe the physical properties of metals.

**C. Basic Joint and Weld Types (120102c) ..... 4 Hours**

**Outcome:** *Identify basic joints and weld types.*

1. Identify the five basic joints.
2. Describe the types of welds and their acceptable dimensions.
3. Identify joint and weld type variations.
4. Outline the major considerations to be accounted for in the design of a joint for welding.

**D. Carbon and Alloy Steels and Alloy Steel Filler Metals (120201c)..... 8 Hours**

**Outcome:** *Identify carbon steels and welding procedures.  
Identify the effects of alloy content on the weldability of steel.  
Identify alloy steel filler metals.*

1. List the carbon content and the uses for low carbon steel, medium carbon steel and high carbon steel.
2. Identify classification systems for steel.
3. Identify the effect of carbon content on the weldability of steel.
4. Identify the effects of elements on the properties of carbon steel.
5. Identify the major alloying elements in alloy steels.
6. Identify the types, properties and weldability of low alloy steels.
7. Identify the properties and weldability of high strength, low alloy steels (HSLA).
8. Identify alloy steel filler material classifications in accordance with AWS and CSA specifications.
9. Identify commonly used low alloy steel filler metals and their applications.

**E. Arc Cutting and Gouging (120102e) ..... 3 Hours**

**Outcome:** *Gouge and cut using carbon arc cutting with air process, and observe plasma arc cutting.*

1. Describe the air carbon arc cutting process.
2. Observe air carbon arc cutting.
3. Describe the plasma arc cutting process and equipment.
4. Observe plasma arc cutting.
5. Demonstrate the ability to operate an air carbon arc cutting process.

- F. Distortion (120201e)..... 3 Hours**
- Outcome: Identify distortion and methods to control it.**
1. Identify how heat and temperature relate to distortion.
  2. Identify the three types of distortion, their causes and control of each type.
  3. Describe the mechanical, procedural and design methods of controlling distortion.
- G. Hardfacing (120201f)..... 3 Hours**
- Outcome: Observe hardfacing of steel.**
1. Describe the hardfacing process and applications.
  2. Identify the types of wear.
  3. Identify filler metals for hardfacing.
  4. Identify the problems associated for applying hardfacing materials.
  5. Describe the procedures for applying hardfacing materials.
  6. Observe hardfacing mild steel plate in the flat position.
- H. Welding Symbols (120204g)..... 7 Hours**
- Outcome: Interpret welding symbols.**
1. Explain the purpose of welding symbols.
  2. Define weld symbol, welding symbol, and supplementary symbols.
  3. Draw and interpret basic weld symbols and welding symbols.
  4. Identify the dimensioning of weld symbols.
  5. Identify non-destructive testing symbol.
- I. Heat Treatment (120304d)..... 7 Hours**
- Outcome: Identify the effects of heat treatment on carbon steels.**
1. Define heat affected zones in metals.
  2. Explain the difference between heat and temperature.
  3. Explain three forms of heat transfer.
  4. Describe the effects of expansion and contraction.
  5. Describe the purpose and effects of:
    - a) preheating
    - b) postheating
  6. Define the following terms and their effects on mechanical properties:
    - a) stress relieving
    - b) normalizing
    - c) annealing
    - d) hardening
    - e) tempering
    - f) quenching
  7. Observe and explain the principle of temperature indicating crayons and other temperature indication devices.

**SECTION THREE: ..... GMAW, FCAW AND SAW ..... 113 HOURS**

**A. Gas Metal Arc Welding (GMAW) Equipment (120103a) ..... 4 Hours**

**Outcome: *Select GMAW Equipment.***

1. Describe the principles of operation of GMAW.
2. Identify the components of a basic GMAW set-up.
3. Describe the modes of metal transfer obtained with GMAW.
4. Describe GMAW power sources and wire feeders.
5. Describe GMAW wire drive systems and gun and cable assemblies.
6. Identify shielding gas supply systems for GMAW.

**B. GMAW Filler Metals, Shielding Gases and Safety (120103b) ..... 4 Hours**

**Outcome: *Select GMAW consumables and apply safe work practices.***

1. Identify GMAW filler metals.
2. Identify shielding gases for GMAW.
3. Identify advantages and disadvantages of GMAW.
4. Identify the precautions you must take against electrical shock, toxic fumes and radiant energy associated with GMAW.

**C. GMAW Equipment Maintenance and Troubleshooting (120103c) ..... 7 Hours**

**Outcome: *Set up, maintain and troubleshoot GMAW equipment.***

1. Describe and demonstrate the set-up and maintenance required for wire drive systems and gun assemblies.
2. Diagnose and demonstrate corrective measures for malfunctioning GMAW equipment.

**D. Flux Cored Arc Welding (FCAW) (120103d) ..... 4 Hours**

**Outcome: *Select and use FCAW equipment and consumables.***

1. Describe the principles of operation of FCAW.
2. Identify the components of a basic FCAW set-up.
3. Describe FCAW power sources, wire feeders and gun and cable assemblies.
4. Describe FCAW operating variables.
5. Identify shielding gases for FCAW.
6. Describe FCAW filler metals.
7. Describe FCAW equipment maintenance and troubleshooting.
8. Identify advantages and disadvantages of FCAW.

**E. Submerged Arc Welding (SAW) (120103e) ..... 5 Hours**

**Outcome: Select SAW equipment and consumables.**

1. Describe the principles of operation of SAW.
2. Identify the components of a basic set-up.
3. Describe SAW power sources, wire feeders, flux feed systems, welding head assemblies and control systems.
4. Describe SAW operating variables.
5. Identify SAW filler metals and fluxes.
6. Describe SAW equipment maintenance and troubleshooting.
7. Identify advantages and disadvantages of SAW.

**F. Shop / Lab Practices: GMAW Welds on gauge and thicker Mild Steel (120103f) ..... 40 Hours**

**Outcome: Perform Surface welds in the flat and horizontal positions on mild steel plate.**

**Perform 1F position welds on mild steel.**

**Perform 2F position welds on mild steel.**

**Perform 3F position welds on mild steel.**

**Perform 1G position welds on mild steel.**

**Perform 2G position welds on mild steel.**

**Perform 3G position welds on mild steel.**

**Perform 1GF position welds on mild steel with backing.**

**Perform 2GF position welds on mild steel with backing**

**Perform 3GF position welds on mild steel with backing.**

1. Demonstrate the ability to weld stringer/ weave beads in the flat and horizontal positions.
2. Demonstrate the ability to weld 1F welds on mild steel plate.
3. Demonstrate the ability to weld fillet welds in the horizontal (2F) position on mild steel plate.
4. Demonstrate the ability to weld fillet welds in the vertical (3F) position (downhill root and uphill fill and cover pass) on mild steel plate.
5. Prepare and fit up butt joints without backing.
6. Demonstrate the ability to weld butt joints in the 1G position.
7. Demonstrate the ability to weld butt joints in the 2G position.
8. Demonstrate the ability to weld butt joints in the 3G position.
9. Optional 4G position on 3/8" material.
10. Demonstrate the ability to weld butt joints in the 1GF position with backing.
11. Demonstrate the ability to weld butt joints in the 2GF position with backing.
12. Demonstrate the ability to weld butt joints in the 3GF position with backing.

**G. Shop /Lab Practices: FCAW Welds on Mild Steel (120103g) ..... 30 Hours**

**Outcome:** *Perform surface welds in the flat and horizontal positions on mild steel.*  
*Perform 1F position welds on mild steel.*  
*Perform 2F position welds on mild steel.*  
*Perform 3F position welds on mild steel.*  
*Perform 1GF position welds on mild steel.*  
*Perform 2GF position welds on mild steel with backing.*  
*Perform 3GF position welds on mild steel with backing.*

1. Demonstrate the ability to weld stringer/ weave beads in the flat and horizontal positions on mild steel plate.
2. Demonstrate the ability to weld 1F welds on mild steel plate.
3. Demonstrate the ability to weld fillet welds in the horizontal (2F) position on mild steel plate.
4. Demonstrate the ability to weld fillet welds in the vertical (3F) position on mild steel plate.
5. Prepare and fit up butt joints with backing.
6. Demonstrate the ability to weld butt joints in the 1GF position on mild steel plate with backing on ½" plate.
7. Demonstrate the ability to weld butt joints in the 2G position on mild steel plate with backing on ½" plate.
8. Demonstrate or perform the knowledge to weld butt joints in the 3GF position on mild steel plate with backing on ½" plate.

**H. Shop / Lab Practices: Combined GMAW and FCAW Welds on Mild Steel (120103h) ..... 5 Hours**

**Labs may be integrated with section F and G.**

**Outcome:** *Perform 1G, 2G, and 3G position welds on mild steel.*

1. Demonstrate the ability to weld butt joints in the 1G position on mild steel using GMAW for the root bead and FCAW fill and cap.
2. Demonstrate the ability to weld butt joints in the 2G position on mild steel using GMAW for the root bead and FCAW fill and cap.
3. Demonstrate the ability to weld butt joints in the 3G position on mild steel using GMAW for the root bead and FCAW fill and cap.

**I. Aluminum and Aluminum Welding (120202e) ..... 4 Hours**

**Outcome:** *Explain basic aluminum welding principles.*

1. Compare the physical and chemical properties of aluminum and steel.
2. Explain how physical and chemical properties affect the welding of aluminum.
3. Explain the aluminum association numerical designation for wrought aluminum alloys.
4. Explain the aluminum association numerical designation for casting alloys.
5. Define the alloys and explain the effects of welding on heat treatable and non-heat treatable alloys.
6. List the preferred welding processes for joining of aluminum and its alloys.
7. List the used filler metals most commonly used for welding aluminum.

**J. GMAW Welds on Aluminum (120203a) ..... 10 Hours**

**Outcome:**    ***Demonstrate the ability to perform flat position welds on aluminum.***  
                  ***Demonstrate the ability to perform horizontal position welds on aluminum.***  
                  ***Demonstrate the ability to perform vertical welds on aluminum.***

1. Demonstrate the ability to weld stringer / weave beads in the flat and horizontal positions on 1/8" (3.2mm) or greater aluminum material.
2. Demonstrate the ability to weld in the 1F position on 1/8" (3.2mm) or greater aluminum material.
3. Demonstrate the ability to observe stringer / weave beads in the horizontal position on aluminum plate.
4. Demonstrate the ability to weld in the 2F position on aluminum plate.
5. Demonstrate the ability to weld in the 3F position on aluminum plate.

**SECTION FOUR: ..... TRADE MATHEMATICS ..... 32 HOURS**

**A. Fractions (120104a)..... 4 Hours**

**Outcome:**    ***Solve problems involving fractions.***

1. Identify key terms and concepts used in working with fractions.
2. Change fractions to a common denominator.
3. Solve problems using whole numbers and fractions.
4. Solve problems using whole numbers and fractions in practical applications.

**B. Decimals (120104b) ..... 4 Hours**

**Outcome:**    ***Solve problems involving decimals.***

1. Read and write decimal fractions.
2. Round decimal fractions to specified place values.
3. Convert decimal inches to a fraction with a practical denominator.
4. Convert decimal feet to feet and inches with a practical denominator.
5. Convert fractions to decimals.
6. Add and subtract decimal fractions.
7. Multiply and divide decimal fractions.

**C. Percentage and Ratios (120104c) ..... 6 Hours**

**Outcome:**    ***Solve problems involving percentage and ratios.***

1. Convert between fractions and percents.
2. Convert between decimals and percents.
3. Calculate ratio problems: two quantities in the form of a ratio and two ratios in the form of a proportion.
4. Solve percent problems.

**D. Geometric Formulas (120104d) ..... 11 Hours**

**Outcome:** *Solve problems involving geometric formulas.*

1. Identify key terms and concepts used in working with formulas.
2. Identify common formulas and solve problems for perimeter.
3. Identify common formulas and solve problems for area.
4. Identify common formulas and solve problems for volume.
5. Calculate the weight of a solid.
6. Calculate the capacity of a container in gallons.

**E. Metric and Imperial Measurement (120104e) ..... 6 Hours**

**Outcome:** *Solve problems involving Metric and Imperial measure.*

1. Identify commonly used metric units of measurement.
2. Convert between units of measurement.
3. Convert imperial units: feet to inches, square inches to square feet, and cubic measures to gallons.

**F. Apprenticeship and Industry Training Board – Industry Network (120104f) ..... 1 Hour**

**Outcome:** *Describe the role of the Alberta Apprenticeship and Industry Training Board and the network of industry committees.*

1. Describe Alberta's Apprenticeship and Industry Training System.
2. Describe the roles and responsibilities of the Alberta Apprenticeship and Industry Training Board, government and post-secondary institutions.
3. Describe the roles and responsibilities of the PAC's, LAC's and occupational committees.



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