COURSE PEN3020: PREPARATORY MATH

Level: Advanced

Prerequisite: None

Description: Students will demonstrate fundamental mathematical concepts and skills required to perform calculations and computations.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform simple calculations using SI units**
   - 1.1 describe basic SI units, matching associated symbols for unit prefixes
   - 1.2 perform unit analyses in simple problems
   - 1.3 list derived SI units and their associated symbols
   - 1.4 perform conversions between SI and imperial units
2. **perform basic arithmetic operations**
   - 2.1 add and subtract integers
   - 2.2 multiply and divide whole numbers and decimal numbers
   - 2.3 perform arithmetic operations involving combinations of addition, subtraction, multiplication, division and powers in the proper order of operation
3. **perform basic arithmetic operations involving fractions, decimals and percentages**
   - 3.1 identify proper and improper fractions and mixed numbers
   - 3.2 add, subtract and multiply fractions and reduce them to lowest terms
   - 3.3 convert fractions to decimal numbers and decimal numbers to fractions
   - 3.4 analyze percentage problems
4. **explain the concepts of ratio and proportion**
   - 4.1 convert ratios of one quantity to another quantity
   - 4.2 solve word problems involving ratios and proportions
5. **identify values for different variables within a formula**
   - 5.1 solve equations and word problems
6. **describe measurement of length; define types of lines and angles; and calculate perimeters and areas of simple plane figures**
   - 6.1 convert measurement units from one system to another using linear measurement systems
   - 6.2 define parallel and perpendicular lines and types of angles
   - 6.3 describe types of simple plane figures, including area calculations for triangles and quadrilaterals
   - 6.4 describe the components of a circle and find its circumference, area and diameter
7. **calculate the volumes and surface areas of of rectangular objects, cylinders and spheres**
   - 7.1 convert commonly used volume units
   - 7.2 calculate the volume of a rectangular prism
   - 7.3 calculate the surface area and volume of a cylinder
   - 7.4 calculate the surface area and volume of a sphere

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8. demonstrate basic competencies

8.1 demonstrate fundamental skills to:

- 8.1.1 communicate
- 8.1.2 manage information
- 8.1.3 use numbers
- 8.1.4 think and solve problems

8.2 demonstrate personal management skills to:

- 8.2.1 demonstrate positive attitudes and behaviours
- 8.2.2 be responsible
- 8.2.3 be adaptable
- 8.2.4 learn continuously
- 8.2.5 work safely

8.3 demonstrate teamwork skills to:

- 8.3.1 work with others
- 8.3.2 participate in projects and tasks

9. create a transitional strategy to accommodate personal changes and build personal values

9.1 identify short-term and long-term goals

9.2 identify steps to achieve goals

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COURSE PEN3021: ELEMENTARY MECHANICS AND DYNAMICS

Level: Advanced

Prerequisite: None

Description: Students will be able to solve problems related to force, work, pressure, stress and friction.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform basic calculations and define basic terms used in the study of mechanics**
   - 1.1 define mass, force, acceleration, velocity and weight
   - 1.2 perform simple calculations involving force, pressure, work, power and energy
2. **perform calculations using forces and moments and determine whether or not a system is in equilibrium**
   - 2.1 define the moment of a force and its units
   - 2.2 determine the direction and magnitude of the moment of a force
3. **define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency**
   - 3.1 define the term simple machine
   - 3.2 calculate mechanical advantage, velocity ratio and efficiency of simple machines
4. **define and identify scalar and vector quantities and solve simple vector problems graphically**
   - 4.1 define scalar and vector quantities as they apply to drawing vector diagrams
5. **solve simple problems involving linear velocity, time and distance**
   - 5.1 solve distance, displacement, speed and velocity problems
   - 5.2 draw graphs of velocity as a function of time
   - 5.3 define acceleration, state its units and solve simple acceleration problems
   - 5.4 apply mathematical formulae relating acceleration, velocity, distance and time to solve problems
6. **perform calculations involving force, work, pressure, power and energy**
   - 6.1 perform calculations involving force and work
   - 6.2 perform calculations involving gauge, atmospheric pressure and absolute pressure
   - 6.3 perform calculations involving power and different forms of mechanical energy
7. **solve problems involving friction**
   - 7.1 apply the laws governing the types of friction
   - 7.2 apply the coefficient of friction to problems involving forces on a horizontal plane
8. **explain physical properties of materials and how their behaviour is affected when external forces are applied**
   - 8.1 describe the characteristics of materials, including elasticity, stiffness, plasticity, ductility, toughness, brittleness and hardness
   - 8.2 calculate stress including tensile, compressive and shear stresses within rigid body members due to external loads
   - 8.3 calculate the strain of members under load

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9. perform calculations pertaining to common power transmission systems

9.1 calculate pulley speeds, transmitted power and efficiency of belt drive systems

9.2 calculate gear speeds for gear and chain drive systems

10. demonstrate basic competencies

10.1 demonstrate fundamental skills to:

- 10.1.1 communicate
- 10.1.2 manage information
- 10.1.3 use numbers
- 10.1.4 think and solve problems

10.2 demonstrate personal management skills to:

- 10.2.1 demonstrate positive attitudes and behaviours
- 10.2.2 be responsible
- 10.2.3 be adaptable
- 10.2.4 learn continuously
- 10.2.5 work safely

10.3 demonstrate teamwork skills to:

- 10.3.1 work with others
- 10.3.2 participate in projects and tasks

11. create a transitional strategy to accommodate personal changes and build personal values

11.1 identify short-term and long-term goals

11.2 identify steps to achieve goals

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COURSE PEN3022: CHEMISTRY AND THERMODYNAMICS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe and define physical and chemical systems and explain how atoms and molecules combine to form compounds, mixtures and solutions. They will be able to apply thermodynamic principles to determine the state of a working fluid and describe how its properties (e.g., temperature, pressure, specific volume and enthalpy) explain its behaviour in specific processes.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify basic types of matter, their properties and the associated chemical principles**
   - 1.1 differentiate among the physical states of matter
   - 1.2 differentiate between chemical and physical changes in matter
   - 1.3 classify matter as either a type of mixture or a pure substance
   - 1.4 describe the purpose and uses of the periodic table using the parts of an atom
   - 1.5 describe the three main ways atoms bond together: covalent, ionic and metallic bonding
   - 1.6 discuss chemical equations and their purpose
   - 1.7 perform simple stoichiometric calculations
   - 1.8 demonstrate how unstable compounds are combined to make stable compounds
2. **explain the principles and laws of thermodynamics**
   - 2.1 define the first two laws of thermodynamics
   - 2.2 define heat and specific heat
   - 2.3 perform sensible heat calculations
   - 2.4 describe the expansion of solids and liquids
3. **explain the modes of heat transfer and the theory of heat-exchanger operation**
   - 3.1 describe the three modes of heat transfer with reference to heat exchangers
   - 3.2 discuss the general design and construction of typical heat exchangers
   - 3.3 describe heat transfer fluids and how they affect the operation of a heat exchanger, including fouling, leakage and vapour locking
   - 3.4 describe heat-exchanger inspection, maintenance and operation, including placing heat exchangers in service and removing them from service
4. **apply the thermodynamic principles through practical applications using the steam tables and the temperature-enthalpy chart**
   - 4.1 describe heat as it relates to steam, water and ice
   - 4.2 explain the various columns of the steam tables
   - 4.3 explain the thermodynamic principles of steam, using the steam tables

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5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:

- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:

- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:

- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals

6.2 identify steps to achieve goals

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COURSE PEN3023: POWER ENGINEERING GOVERNANCE

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the profession of the power engineer and the importance of jurisdictional regulations, codes and standards.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the power engineer profession**
   - 1.1 describe steam, its uses and the basic steam cycle
   - 1.2 describe the role and duties of a power engineer
   - 1.3 describe how shift work affects sleep patterns, diet and overall health
2. **describe the application of jurisdictional acts and regulations with respect to power engineers, boilers and pressure vessels**
   - 2.1 describe how the power engineering profession is regulated in Canada
   - 2.2 explain the purpose and scope of jurisdictional acts and regulations pertaining to power engineering and pressure equipment
   - 2.3 explain the purpose and intent of the regulations governing power engineers and pressure welders
3. **describe the purpose of boiler and pressure vessel codes and standards**
   - 3.1 discuss the history of how codes and standards became necessary in the pressure-equipment field
   - 3.2 explain the content and use of the *CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code*
   - 3.3 explain the content and use of the *CSA B52 Mechanical Refrigeration Code*
   - 3.4 explain the content and use of *ASME Boiler and Pressure Vessel Code* (*ASME BPVC*) Section I—Power Boilers
   - 3.5 explain the content and use of *ASME BPVC* Section VII—Recommended Guidelines for the Care of Power Boilers
   - 3.6 explain the content and use of *ASME BPVC* Section IV—Rules for Construction of Heating Boilers
   - 3.7 explain the content and use of *ASME BPVC* Section VI—Recommended Rules for the Care and Operation of Heating Boilers
   - 3.8 explain the purpose, intent and limitation of *ASME CSD-1 (Controls and Safety Devices for Automatically Fired Boilers) Standard*
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems

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4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3024: PLANT AND FIRE SAFETY

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the elements of maintaining a safe work environment, including fire safety and using and maintaining fire extinguishing equipment.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe general plant safety as it relates to power engineers**
   - 1.1 discuss the cost and effects of workplace accidents
   - 1.2 describe the basic hazards that may be in an energy plant and the basic personal protective equipment that may be required
   - 1.3 define, give examples of and describe common powerhouse hazards
   - 1.4 describe industrial health and safety management systems
   - 1.5 describe hazard assessment and control programs
2. **describe common safety programs generally applied in plants**
   - 2.1 describe common occupational health and safety (OH&S) programs found in most plants
   - 2.2 describe industrial safety training programs in which power engineers may require additional training
   - 2.3 discuss safe work permits
   - 2.4 describe methods of equipment isolation and lockout
3. **describe the policies and procedures for safe storage and handling of dangerous materials**
   - 3.1. discuss the WHMIS system
   - 3.2. discuss the essential components required in the WHMIS system
   - 3.3. describe the safe handling and use of gas cylinders in an energy plant (power plant)
   - 3.4. discuss the safe handling of hydrocarbons
4. **explain fire safety in an industrial plant**
   - 4.1 discuss the theory, terminology and the life safety issues associated with fires
   - 4.2 explain the five classes of fires and describe the types of fire extinguishing media and how they act on these fires
   - 4.3 explain fire prevention methods for the five classes of fires
5. **describe typical fire extinguishing equipment and its operation in plant environments**
   - 5.1 describe the construction and operation of various types of portable fire extinguishers
   - 5.2 discuss the inspection and maintenance requirements for portable fire extinguishers
   - 5.3 describe the types, layout and operation of standpipe and sprinkler systems
   - 5.4 discuss the maintenance requirements of standpipe and sprinkler system components
   - 5.5 describe the purpose, operation and maintenance of fire pumps

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6. demonstrate basic competencies

- 6.1 demonstrate fundamental skills to:
  - 6.1.1 communicate
  - 6.1.2 manage information
  - 6.1.3 use numbers
  - 6.1.4 think and solve problems
- 6.2 demonstrate personal management skills to:
  - 6.2.1 demonstrate positive attitudes and behaviours
  - 6.2.2 be responsible
  - 6.2.3 be adaptable
  - 6.2.4 learn continuously
  - 6.2.5 work safely
- 6.3 demonstrate teamwork skills to:
  - 6.3.1 work with others
  - 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

- 7.1 identify short-term and long-term goals
- 7.2 identify steps to achieve goals

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COURSE PEN3025: ENVIRONMENTAL IMPACT

Level: Advanced

Prerequisite: None

Description: Students will be able to identify environmental considerations for reducing or eliminating energy plant emissions.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify environmental considerations and how they relate to an operating plant**
   - 1.1 describe four important biogeochemical cycles that operate within the environment: oxygen, water, carbon and soil cycles
   - 1.2 describe typical interdependencies seen among elements within an ecosystem
   - 1.3 list the types of impacts that operating facilities can have on the environment
   - 1.4 describe the alert processes related to environmental problems of plants
   - 1.5 explain the importance of attitude in limiting the environmental impacts of plants
   - 1.6 describe the long-term environmental impacts that remain after the decommissioning and abandonment of plants
2. **explain how gas and noise emissions affect plant operations**
   - 2.1 identify the sources and effects of common gases and vapours that have an adverse environmental impact
   - 2.2 identify the common greenhouse- and acid-rain-causing gases and describe their effects
   - 2.3 describe the common methods for monitoring and reducing gaseous pollutants
   - 2.4 describe the effects of noise pollution and methods of identifying, measuring and controlling noise pollution
3. **explain how liquid and solid emissions affect plant operation**
   - 3.1 describe the sources and effects of solid pollutants from energy plants
   - 3.2 describe the theory of operation of separators/collectors and monitoring of flue-gas particulates
   - 3.3 describe the disposal methods of solid waste from energy plants
   - 3.4 list sources and effects of liquid waste and thermal pollution
   - 3.5 describe the preventive measures that can be taken to prevent liquid and thermal pollution
   - 3.6 describe methods of liquid waste disposal
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible

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4.2.3 be adaptable
4.2.4 learn continuously
4.2.5 work safely

4.3 demonstrate teamwork skills to:
4.3.1 work with others
4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3026: MATERIAL SCIENCE AND WELDING

Level: Advanced

Prerequisite: None

Description: Students will be able to describe properties of engineering materials, as well as welding processes and testing methods.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the mechanical properties of engineering materials**
   - 1.1 describe the mechanical properties of materials
   - 1.2 describe the various types of ferrous materials
   - 1.3 describe the various types of nonferrous materials
2. **describe welding processes relevant to the plant and power engineering**
   - 2.1 describe the non-fusion welding process, equipment used and methods
   - 2.2 describe forge and oxyfuel fusion welding processes and cutting processes
   - 2.3 describe metal arc welding processes
   - 2.4 describe heat treatment of welds
   - 2.5 describe the types of weld joints used in pressure-vessel construction
   - 2.6 describe the additional construction components required for pressure vessels to ensure structural integrity and access
3. **describe inspection processes and testing methods for welds and materials**
   - 3.1 describe common weld defects
   - 3.2 describe the process of visual testing of welds
   - 3.3 describe the process of penetrant testing for detecting weld or material defects
   - 3.4 describe the process of radiographic weld testing
   - 3.5 describe the process of ultrasonic weld testing
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely
   - 4.3 demonstrate teamwork skills to:
     - 4.3.1 work with others
     - 4.3.2 participate in projects and tasks

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5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals

5.2 identify steps to achieve goals

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COURSE PEN3027: FLUID-HANDLING TECHNOLOGY

Level: Advanced

Prerequisite: None

Description: Students will be able to describe piping materials and methods, as well as the design, use and maintenance of valves.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the basic types of piping, piping connections, supports and drainage devices used in industry**
   - 1.1 state the applications for the most common materials
   - 1.2 identify the sizes of commercial pipe
   - 1.3 describe methods of connection for screwed, flanged and welded pipe
   - 1.4 identify pipefittings and their markings
   - 1.5 describe methods and devices used to allow for pipe expansion and support
   - 1.6 explain the methods used to promote good drainage of steam pipes, including the installation and maintenance of steam traps to reduce the effects of water hammer
   - 1.7 explain the requirements, materials used and methods for insulating pipe
2. **describe the design and operation of the valves most commonly used in industry and on boilers**
   - 2.1 describe standard valve designs
   - 2.2 describe the design and operation of specialized boiler valves
   - 2.3 describe a typical steam pressure reducing station and the design and operation of steam system pressure-reducing valves
   - 2.4 discuss valve details, including construction materials and identification markings
   - 2.5 describe typical valve maintenance requirements
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks

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4. create a transitional strategy to accommodate personal changes and build personal values

4.1 identify short-term and long-term goals

4.2 identify steps to achieve goals

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COURSE PEN3028: ELECTROTECHNOLOGY

Level: Advanced

Prerequisite: None

Description: Students will be able to apply the concepts of basic electricity and magnetism to the operation of AC and DC motors, generators and transformers. Students will be able to describe the power distribution system used for power plant operation.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **apply the concepts of basic electricity while performing simple calculations using voltage, current, resistance and power**
   - 1.1 describe the atomic structure of matter and its relationship to electricity
   - 1.2 describe basic electrical circuits
   - 1.3 state Ohm's Law and apply it to single resistor circuits
   - 1.4 apply Ohm's Law to series resistance circuits
   - 1.5 apply Ohm's Law to parallel resistance circuits
   - 1.6 explain electrical conductors and insulators using examples
   - 1.7 explain the factors that affect resistance mathematically
   - 1.8 calculate the power developed in an electrical circuit
2. **describe the basic principles of magnetism**
   - 2.1 describe electrical meters and their uses
   - 2.2 describe how voltage, current and resistance are measured in an electric circuit
   - 2.3 describe the construction and operation of a kilowatt hour meter
3. **describe the operating principles of the various types of AC and DC motors and generators**
   - 3.1 describe the construction and operation of DC generators and motors
   - 3.2 describe the construction and operation of AC generators (alternators) and motors
   - 3.3 interpret the information on a motor nameplate
   - 3.4 perform basic calculations relating to power factor and power factor correction
4. **describe the operating principles of electrical transformers**
   - 4.1 describe the principle of operation of transformers
   - 4.2 perform basic transformer calculations as they relate to the construction and operation of single-phase transformers
   - 4.3 describe the construction and operation of three-phase transformers
   - 4.4 discuss special types of transformers and their applications
   - 4.5 discuss cooling, safety and maintenance of transformers
5. **describe an electrical distribution system**
   - 5.1 list and describe the standard types of electrical voltage systems
   - 5.2 interpret electrical single-line diagrams and circuit symbols
   - 5.3 describe the major components of an electrical distribution system

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5.4 describe the function and operation of fuses and circuit breakers
5.5 describe the function and operation of alternate power supply system equipment

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3029: INSTRUMENTATION AND CONTROLS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the purpose, function and operation of energy plant instrumentation systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the overall purpose and function of plant instrumentation systems**
   - 1.1 describe the concept and basic components of a control loop
   - 1.2 describe the various means by which control signals are transmitted and the function of transducers
   - 1.3 list and describe the types of instruments that are not control-loop components
2. **describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity and composition**
   - 2.1 describe the types of pressure-sensing and measuring devices
   - 2.2 describe the types of level-sensing and measuring devices
   - 2.3 describe the types of flow-sensing and measuring devices
   - 2.4 describe the types of temperature-sensing and measuring devices
   - 2.5 describe the types of humidity-sensing and measuring devices
   - 2.6 describe the types of gas-sensing (composition) and measuring devices
3. **describe the basic types and functions of transmitters, recorders, controllers and control actuators**
   - 3.1 describe the construction and operational principles of instrumentation transmitters
   - 3.2 describe the construction and operational principles of instrumentation indicators and recorders
   - 3.3 describe the construction and operational principles of instrumentation controllers
   - 3.4 describe the construction and operational principles of final control elements
4. **describe the operation of programming controls for boilers, including applicable testing and maintenance procedures**
   - 4.1 discuss how programmable controllers work and how they act as sequencers for equipment
   - 4.2 describe applications of programmable controllers
   - 4.3 explain the HMI (human-machine interface) and the purpose of touchscreen displays, functions and alarm-handling
5. **describe the design and operation of electronic control systems**
   - 5.1 discuss electronic process control systems
   - 5.2 describe computers and how they operate within control systems
   - 5.3 describe the applications of computerized control systems and plant computers

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6. describe the design and operation of electrical control systems

6.1 describe the basic construction and operation of various components of electrical control systems

6.2 describe the function of control devices in electrical control systems

6.3 explain the operating sequence of basic electrical control circuits

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:

- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:

- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:

- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3030: INDUSTRIAL COMMUNICATION

Level: Advanced

Prerequisite: None

Description: Students will be able to interpret and sketch plant drawings and diagrams.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **create engineering equipment sketches**
   - 1.1 create sketches using centre lines and dimensioning
   - 1.2 recognize standard views of an object
   - 1.3 recognize cross-hatching methods in sectional drawings
   - 1.4 identify common drawing symbols and lines used in plant system trace drawings
   - 1.5 complete a plant trace drawing
2. **identify common types of diagrams used in plants**
   - 2.1 explain the layout of a plant diagram
   - 2.2 explain the use of a process flow diagram (PFD)
   - 2.3 explain the use of a piping and instrumentation diagram (P&ID)
   - 2.4 explain the use of general arrangement, a block plan and an equipment diagram
3. **describe the types and proper usage of plant communication systems**
   - 3.1 discuss effective written and verbal communication skills, including the use of two-way radios
   - 3.2 describe the legal documentation requirements for power engineers, including log books and log sheets
   - 3.3 discuss the elements of maintenance management systems, including work requests and work orders
   - 3.4 discuss the purpose, revision and control of standard operating procedures
   - 3.5 discuss updating procedures for a piping and instrumentation diagram
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely

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4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3031: BOILER DESIGNS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the design, components, construction, characteristics and operation of various types of boilers.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the historical development of boilers, boiler design, components and configuration**
   - 1.1 describe the history of boiler applications, design and modern boiler improvements
   - 1.2 describe packaged boilers
   - 1.3 describe the construction of field-assembled and field-erected boilers
   - 1.4 describe components and design aspects common to all boiler vessels
2. **describe the design, components and characteristics of fire-tube boilers**
   - 2.1 differentiate the scotch boiler from the other fire-tube boilers and describe the scotch boiler's development history
   - 2.2 describe circulation patterns in fire-tube boilers
   - 2.3 discuss construction details of fire-tube boilers
3. **describe the design, components and characteristics of water-tube boilers**
   - 3.1 describe the design and operating principles of water-tube boilers
   - 3.2 describe water-tube boiler components
   - 3.3 explain the design and application of packaged water-tube boilers
   - 3.4 describe the design, construction and components of large-scale steam-generating units
4. **explain the general design and application of electric boilers**
   - 4.1 discuss the advantages and disadvantages of electric boilers
   - 4.2 describe the construction and operating principle of electric boilers
5. **describe the special design considerations of boilers used in heating plants**
   - 5.1 describe the design of water-tube and coil-tube heating boilers
   - 5.2 describe cast iron boilers and vertical fire-tube boilers
   - 5.3 describe the construction and application of fire-tube heating boiler designs
6. **differentiate between power boilers and heating boilers**
   - 6.1 discuss the differences between power boiler and heating boiler design and installation
   - 6.2 discuss the differences between power boiler and heating boiler operation
7. **demonstrate basic competencies**
   - 7.1 demonstrate fundamental skills to:
     - 7.1.1 communicate
     - 7.1.2 manage information
     - 7.1.3 use numbers
     - 7.1.4 think and solve problems

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7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3032: BOILER SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the systems used in the operation and maintenance of boiler systems (e.g., combustion, fuel, draft, feedwater, blowoff and blowdown and fireside cleaning).

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the basic theory of combustion and the equipment used to provide proper combustion conditions within a boiler**
   - 1.1 discuss combustion, combustion equations and the relationship between theoretical and excess air
   - 1.2 discuss the characteristics of solid, liquid and gaseous fuels
   - 1.3 explain fuel and the effects of combustion on refractory materials
2. **describe common fuel systems found in boiler systems**
   - 2.1 describe solid-fuel delivery systems
   - 2.2 describe the main types of solid-fuel firing systems
   - 2.3 describe gaseous-fuel delivery systems
   - 2.4 describe the main types of gaseous-fuel firing systems
   - 2.5 describe liquid-fuel delivery systems
   - 2.6 describe the main types of liquid-fuel firing systems
   - 2.7 describe flue-gas analysis and how it relates to boiler efficiency
3. **describe basic concepts and equipment used to supply combustion air to boiler furnaces**
   - 3.1 describe the various air streams that deliver combustion air to a furnace
   - 3.2 relate differential pressure to the creation of draft
   - 3.3 describe forced, induced and balanced mechanical draft
   - 3.4 discuss common methods of controlling combustion airflow
   - 3.5 discuss common methods of measuring furnace pressures
4. **describe feedwater systems used with boilers**
   - 4.1 describe the overall layout of feedwater, condensate and make-up of water systems
   - 4.2 describe the valves used in feedwater systems
   - 4.3 describe the control strategies for single-element, two-element and three-element boiler feedwater systems
   - 4.4 describe methods of supplying feedwater to steam-heating boilers
   - 4.5 explain the operation of condensate receiver make-up water controls
   - 4.6 describe the return of condensate and the supply of feedwater to high-pressure boilers

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5. describe the purpose, equipment and operation of blowdown in boiler systems

5.1 describe blowoff, blowoff equipment and blowoff procedures
5.2 describe continuous blowdown, blowdown equipment and blowdown procedures
5.3 describe the maintenance and repair of blowoff systems

6. describe types of boiler fireside cleaning equipment, their purpose and their operation

6.1 describe common options for in-service fireside cleaning
6.2 describe the construction and operation of retractable soot blowers
6.3 describe the construction and operation stationary soot blowers
6.4 describe shot cleaning methods

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3033: LUBRICATION AND BEARINGS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the purpose and properties of lubrication for the maintenance and care of bearing systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the importance of lubrication and the principles concerned with lubrication**
   - 1.1 discuss the concept of lubrication
   - 1.2 list the purposes of a lubricant
   - 1.3 list the various classes and types of lubricants
   - 1.4 describe the properties and application of lubricants
   - 1.5 list the properties of lubricating oils, the additives used and their selection criteria
2. **describe bearing types, methods for care and maintenance of bearings and bearing lubrication systems**
   - 2.1 define boundary lubrication and full fluid-film lubrication
   - 2.2 describe shell (sleeve) bearings
   - 2.3 describe the construction and operation of antifriction bearings and thrust bearings
   - 2.4 describe how to clean and replace roller- and ball-type bearings
   - 2.5 explain the causes of bearing failure
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks
4. **create a transitional strategy to accommodate personal changes and build personal values**
   - 4.1 identify short-term and long-term goals
   - 4.2 identify steps to achieve goals

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COURSE PEN3034: PUMPS AND COMPRESSORS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operation and maintenance of various types of pumps and compressors used in power plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the construction and operating principles of various types of pumps used in power plants**
   - 1.1 list the common pump applications
   - 1.2 define the terms associated with pump performance
   - 1.3 describe the common pumps found in power plants
2. **describe the major considerations and procedures for pump operation and maintenance**
   - 2.1 discuss the components of a motor and a pump assembly
   - 2.2 describe the types of shaft seals
   - 2.3 describe standard types of mechanical seals
   - 2.4 describe pump-bearing and shaft-alignment equipment and procedures
   - 2.5 describe centrifugal pump start-up and priming procedures
   - 2.6 describe positive-displacement pump priming, start-up and routine
3. **describe the operating principles of the different types of compressors**
   - 3.1 describe the main classifications and types of compressors
   - 3.2 describe gaseous compression systems
4. **describe the major considerations and general procedures for compressor operation and maintenance**
   - 4.1 describe compressor parts and auxiliary equipment
   - 4.2 describe the construction and operation of seals for compressors
   - 4.3 describe the capacity control of compressors
   - 4.4 describe preventive maintenance and routine procedures for compressors
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously
     - 5.2.5 work safely

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5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

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COURSE PEN3035: BOILER SAFETY DEVICES

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the safety requirements, equipment and controls related to the safe operation of boilers.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the code requirements, design and operation of pressure relief valves for power boilers, heating boilers and pressure vessels**
   - 1.1 discuss the code requirements, construction and operation of ASME Section I pressure relief valves and devices
   - 1.2 discuss the code requirements, construction and operation of ASME Section IV pressure relief valves and devices
   - 1.3 describe the testing and repair of pressure relief valves
   - 1.4 describe the construction and operation of a temperature (temperature and pressure) relief device
2. **explain the design and operation of combustion safety controls on burners and boilers**
   - 2.1 describe basic boiler control systems
   - 2.2 compare the devices/controls that can be either operating or safety circuits
   - 2.3 describe a burner management system (BMS)
   - 2.4 describe the equipment operation process used to start-up and shutdown boilers
   - 2.5 interpret burner operating sequence bar graphs
   - 2.6 provide a typical sequence of start-up and shutdown events
   - 2.7 describe the construction and operation of burner/boiler flame failure detectors
   - 2.8 identify testing requirements for burner/boiler flame failure safety devices
3. **describe feedwater safety devices and control methods used on boilers**
   - 3.1 describe the construction and operation of boiler low-water-level fuel-cutoff equipment
   - 3.2 list the ASME and CSA code regulations regarding low-water fuel-cutoff devices
   - 3.3 describe testing and maintenance of boiler low-water-level fuel cutoffs
   - 3.4 describe direct- and indirect-type water-level indicators
4. **relate the operation and required fittings described in the code to the operating principles of fittings found on boilers**
   - 4.1 explain the code references for boiler fittings
   - 4.2 describe the code requirements for pressure gauges on steam boilers
   - 4.3 describe the code requirements for boiler connections and valves on steam boilers
   - 4.4 describe the code requirements for required fittings on hot-water boilers
   - 4.5 describe types of non-code required fittings used on boilers
   - 4.6 describe the trim items found on power and heating boilers

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5. describe the operating and safety controls found on boilers

5.1 discuss various operating controls for steam boilers and hot-water boilers
5.2 describe the safety controls found on boiler and burner systems
5.3 describe the operation of control and safety devices found on the fuel supplies of boilers
5.4 describe testing and maintenance requirements for boiler controls

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3036: BOILER PLANT OPERATION AND MANAGEMENT

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operational procedures for start-up, operation, management and shutdown of boiler plant systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe operational procedures related to start-up of auxiliary equipment in a boiler plant**
   - 1.1 describe the basic auxiliaries that need to be checked, prepared or placed in service before starting a boiler plant
   - 1.2 describe the general procedures for starting a plant for the first time or restarting after an outage or turnaround
   - 1.3 discuss basic operating practices for starting pumps and fans
   - 1.4 describe the general preparation for a hot-water boiler start-up
   - 1.5 describe the general preparation for a steam boiler start-up
   - 1.6 describe the safety and housekeeping preparation requirements for boiler plant start-up
2. **describe procedures for safely starting boiler systems**
   - 2.1 describe operation considerations when warming a cold boiler
   - 2.2 describe how to start and cut in a hot-water boiler
   - 2.3 describe how to start a single-boiler steam plant
   - 2.4 describe how to cut in a steam boiler in a multiple-boiler plant
   - 2.5 describe semi-automatic burner ignition systems
   - 2.6 discuss the post start-up inspection for boilers returning to service after a major outage
3. **describe operational procedures related to operating boilers**
   - 3.1 describe the operation of a hot-water boiler under routine conditions
   - 3.2 describe routine steam boiler operating duties
   - 3.3 describe emergency conditions in boiler plants and the required responses
   - 3.4 describe troubleshooting activities for basic boilers
4. **describe operational checks for operating boiler plants**
   - 4.1 describe the shift-based operator responsibilities for boiler plants
   - 4.2 describe the safety device operational checks carried out on boilers
   - 4.3 describe routine maintenance activities for boiler plant operation
   - 4.4 describe the use of standard operating procedures (SOPs)
   - 4.5 describe the need for boiler operating and maintenance logs and the type of information that should be recorded
5. **describe generic shutdown and lay-up procedures for different boiler types**
   - 5.1 describe hot-water boiler shutdown procedures
   - 5.2 describe hot-water boiler extended period lay-up requirements

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5.3 describe steam boiler shutdown and lockout procedures
5.4 describe extended period lay-up requirements for steam boilers

6. describe the points and readings that need to be monitored and recorded in a plant

6.1 discuss recording requirements for operating and performance conditions
6.2 discuss the various systems required to conduct equipment repairs and to manage the related maintenance records
6.3 describe the operational causes, consequences and prevention of water hammer
6.4 describe the consequences and actions required for common equipment failures
6.5 describe the consequences and actions required in the event of boiler accidents

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3037: ENERGY PLANT MAINTENANCE

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the use of hand tools and hoisting and rigging equipment, as well as boiler equipment service, maintenance and cleaning methods.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the safe use of common hand tools in the powerhouse**
   - 1.1 describe the types and proper use of equipment, including hacksaws, files, chisels, hammers, screwdrivers and wrenches
   - 1.2 describe the types and proper use of hand threading tools
   - 1.3 describe the types and proper use of measuring tools
   - 1.4 describe the proper layout of work and the use of layout tools
   - 1.5 describe the types and proper use of portable and fixed grinders, hand drills and drill presses and the care of drill bits
2. **describe the safe and proper setup of equipment for hoisting and working above ground**
   - 2.1 describe the requirements for setting up work platforms, in general, and ladders and scaffolding, in particular
   - 2.2 describe the general safety precautions and calculations used when rigging equipment
   - 2.3 describe the general safety precautions used when hoisting equipment
   - 2.4 discuss the correct use and limitations of wire cable and rope, including cable attachments and rope knots
   - 2.5 list and describe common types of metal fasteners, such as screws, bolts, studs, nuts and washers
3. **describe the service and maintenance required for boilers**
   - 3.1 describe the general maintenance and servicing requirements for packaged fire-tube and cast iron sectional boilers
   - 3.2 identify the operational procedures for wet and dry boiler lay-ups
   - 3.3 describe ways of detecting fire tube and tubesheet leaks
   - 3.4 describe the general procedure for the removal and replacement of defective fire tubes
4. **discuss the procedure for preparing a boiler for inspection and cleaning and describe mechanical and chemical boiler cleaning methods**
   - 4.1 list the steps and precautions needed to prepare a boiler for inspection
   - 4.2 describe the internal inspection of a boiler
   - 4.3 describe the methods and tools used to mechanically clean boilers
   - 4.4 describe two methods used to chemically clean boilers

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5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:

- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:

- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:

- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals

6.2 identify steps to achieve goals

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COURSE PEN3038: IN-PLANT WATER TREATMENT

Level: Advanced

Prerequisite: None

Description: Students will be able to describe water treatment principles, methods and equipment used in an energy plant.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the general principles, methods and equipment used in preparing raw feedwater for steam production**
   - 1.1 describe typical impurities and their effects on plant and boiler water pre-treatment systems and their treatment process
   - 1.2 describe the equipment requirements for pre-treatment of energy plant water systems
   - 1.3 describe water filtration and the removal of suspended solids
   - 1.4 describe the purpose, processes and equipment used in water softening
   - 1.5 describe the theory, processes and equipment used in deaeration
2. **describe the general principles, methods and equipment used for internal boiler water treatment**
   - 2.1 describe the types of problems and associated treatments related to internal boiler water contamination
   - 2.2 describe internal boiler feedwater chemical-feed systems
   - 2.3 describe standard boiler water tests, measurement and treatment
3. **discuss the general principles, methods and equipment used for the treatment of condensate**
   - 3.1 describe condensate treatment and the effects of non-treatment
   - 3.2 describe the tests conducted on condensate
4. **discuss the general principles, methods and equipment used for the treatment of condenser water and their effects on the cooling tower**
   - 4.1 describe the effects of water on condensers and cooling-tower materials
   - 4.2 describe condenser water systems and water treatment
   - 4.3 describe cooling-tower and condenser water tests addressing common treatments
5. **describe recirculating-water systems and their effects, treatment and tests**
   - 5.1 describe recirculating-water system corrosion and deposition
   - 5.2 describe the use of sacrificial anodes and measurement techniques to determine corrosion
   - 5.3 describe glycol-system testing requirements
   - 5.4 discuss the monitoring tools, procedures and tests used in recirculating-water systems
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information

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6.1.3 use numbers
6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
6.2.1 demonstrate positive attitudes and behaviours
6.2.2 be responsible
6.2.3 be adaptable
6.2.4 learn continuously
6.2.5 work safely

6.3 demonstrate teamwork skills to:
6.3.1 work with others
6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3039: PRIME MOVERS AND HEAT ENGINES

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the conversion of heat energy into mechanical energy and the use and operation of steam and gas turbines, condensers and cooling towers and combustion engines in an energy plant.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the historical conversion of heat energy into mechanical energy**
   - 1.1 differentiate between the terms heat engine and prime mover
   - 1.2 discuss the history of the steam engine and the expansive power of steam
2. **describe the construction and operation of steam turbines**
   - 2.1 describe the principle of operation and major components of a steam turbine
   - 2.2 describe the lubrication and sealing requirements for steam turbine shafts
   - 2.3 describe how the rotational speed of a steam turbine is governed and controlled
   - 2.4 list the steps to follow in a typical steam turbine start-up and shutdown
3. **describe the operation and maintenance of condensers and cooling towers**
   - 3.1 explain the construction and operation of condensers and how they relate to the operation of cooling towers
   - 3.2 explain the principle of operation, the purpose and the major components of cooling towers
   - 3.3 describe the construction and operation of natural draft cooling towers
   - 3.4 describe the construction and operation of mechanical draft cooling towers
   - 3.5 discuss cold-climate operation for cooling towers
   - 3.6 explain typical problems and resolutions required within the operation of cooling towers
4. **describe the application, start-up, operation and maintenance required for gas turbines**
   - 4.1 describe the principle of construction and operation of gas turbines
   - 4.2 identify the operational characteristics of gas turbines
   - 4.3 describe regeneration and combined steam-gas turbine operating cycles
   - 4.4 describe the key elements of gas turbine start-up, operation and auxiliaries
5. **describe the application, construction and operation of internal combustion engines**
   - 5.1 discuss the fuels used in internal combustion engines
   - 5.2 describe the working cycles of the four-stroke and two-stroke spark ignition engines
   - 5.3 describe the working cycle of the four-stroke compression ignition (i.e., diesel) cycle
   - 5.4 describe the construction of basic spark and compression cycle engines
   - 5.5 explain the basic operating considerations for diesel engines
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate

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6.1.2 manage information
6.1.3 use numbers
6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
6.2.1 demonstrate positive attitudes and behaviours
6.2.2 be responsible
6.2.3 be adaptable
6.2.4 learn continuously
6.2.5 work safely

6.3 demonstrate teamwork skills to:
6.3.1 work with others
6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3040: AUXILIARY BUILDING SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe various lighting systems, water supply systems and drainage systems used in energy facilities.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the various lighting systems and some of the basic design considerations for lighting a space**
   - 1.1 describe the common types of lighting equipment and systems
   - 1.2 discuss the different types of artificial light sources
   - 1.3 explain the various methods of lighting control
   - 1.4 describe the general requirements and criteria for emergency lighting in buildings
   - 1.5 discuss the interrelationship between lighting, air conditioning and energy conservation in buildings
2. **explain the various water supply systems used in buildings and plants**
   - 2.1 describe the cold-water distribution system in buildings and plants
   - 2.2 describe the hot-water distribution system in buildings and plants
   - 2.3 describe the construction and operation of building system hot-water heaters, including temperature regulation
   - 2.4 describe the construction and operation of water system protective devices in buildings
   - 2.5 explain what is meant by backflow prevention and describe the common methods used
   - 2.6 describe the maintenance requirements for the components in a building water distribution system
3. **describe the design and components of various drainage systems used in facilities**
   - 3.1 describe the overall layout of building drainage systems
   - 3.2 describe stormwater drainage systems for buildings
   - 3.3 describe how surface runoff is managed to minimize environmental impact
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely

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4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3041: REFRIGERATION

Level: Advanced

Prerequisite: None

Description: Students will be able to explain refrigeration, the properties of refrigerants and the operation and the maintenance of compression and absorption refrigeration systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the basic concept of refrigeration and refrigerants**
   - 1.1 explain the fundamentals of refrigeration
   - 1.2 describe the cycle of operations in a vapour-compression refrigeration system
   - 1.3 explain how operating temperatures and pressures are selected and related for a vapour-compression refrigeration system
   - 1.4 state how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance
   - 1.5 describe how refrigerants are classified
   - 1.6 describe the thermodynamic properties of refrigerants
   - 1.7 describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity and flammability
   - 1.8 describe the safety concerns of common refrigerants, such as R 717, CFCs and HCFCs
2. **describe the operating principles of compression refrigeration systems**
   - 2.1 describe the basic layout of compression refrigeration systems
   - 2.2 distinguish between direct and indirect refrigeration systems
   - 2.3 describe the layout of packaged refrigeration systems and the role of a refrigeration economizer
   - 2.4 describe the special types of refrigeration compressors and how regular compressors are adapted for refrigeration use
   - 2.5 describe the special designs of refrigeration system evaporators and condensers
   - 2.6 discuss refrigeration condenser operation and maintenance requirements
3. **describe the purposes and operating principles of refrigeration system operational and safety controls**
   - 3.1 describe the special application of controls in a refrigeration system
   - 3.2 list the safety shutdown devices specific to centrifugal compressor water chillers
   - 3.3 describe typical refrigeration system safety shutdown devices
   - 3.4 describe the construction and operation of compression refrigeration cycle expansion valves
   - 3.5 describe the different methods used to control the capacity of evaporators
   - 3.6 describe the different methods used to control the capacity of refrigeration compressors
   - 3.7 discuss refrigeration auxiliaries
   - 3.8 identify procedures for refrigeration system leak tests

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3.9 describe how a refrigeration system is dried and charged prior to start-up
3.10 list the steps for adding oil to an in-service refrigeration compressor
3.11 describe the start-up and shutdown procedures for a compression refrigeration system
3.12 describe operational log sheets and preventative maintenance procedures for refrigeration systems
3.13 describe how a refrigeration system is purged of non-condensable gases
3.14 describe condenser operation and maintenance
3.15 explain typical problems and resolution related to refrigeration systems

4. describe the operating principle, maintenance and operation of absorption refrigeration systems

4.1 describe the basic absorption system, comparing differences to the compression system
4.2 describe the theory and operation of an ammonia absorption refrigeration system
4.3 describe the theory and operation of a lithium bromide absorption refrigeration system
4.4 explain the operation of absorption refrigeration systems with respect to crystallization and dilution
4.5 describe the major parts/systems of an absorption system, including heat exchanger bypass system, pump motor cooling and lubrication and purging system
4.6 describe the start-up and shutdown procedures for an absorption refrigeration system
4.7 describe the preventive maintenance that should be performed on an absorption refrigeration system
4.8 explain typical problems and resolutions related to an absorption refrigeration system

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

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COURSE PEN3042: HEATING, VENTILATING AND AIR CONDITIONING

Level: Advanced

Prerequisite: None

Description: Students will be able to describe methods for air distribution, conditioning and humidification used in buildings and energy plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the methods and techniques for conditioning air for energy plants and buildings**
   - 1.1 discuss the process to condition air for human comfort and health
   - 1.2 list the categories and functions of heating, ventilating and air conditioning (HVAC) systems
   - 1.3 describe the operation of air-handling units
   - 1.4 define the terms humidity, relative humidity and dew point
   - 1.5 define the terms dry-bulb temperature and wet-bulb temperature and describe how they relate to relative humidity
2. **explain the equipment and principles of humidification**
   - 2.1 describe the general purpose and principles of humidification
   - 2.2 describe residential and warm-air types of humidifiers
   - 2.3 describe industrial and commercial types of humidifiers
3. **describe airflow behaviour and the movement of air through distribution systems**
   - 3.1 discuss the theory of airflow and pressure conversions
   - 3.2 describe the major types of air-handling fans and their construction and operation
   - 3.3 interpret fan-performance curves
   - 3.4 describe fan motors, drives and belt guards
   - 3.5 describe fan-volume controls
4. **describe various ventilation systems, including various types of air filters used in these systems**
   - 4.1 explain the difference between natural and mechanical ventilation
   - 4.2 describe the various contaminants found in air
   - 4.3 describe the types of air-cleaning devices used in industrial/commercial buildings
5. **describe the designs and components of duct systems used in HVAC applications**
   - 5.1 explain how systems of air ducts are classified
   - 5.2 describe air-duct materials, system layout, fabrication and installation
   - 5.3 describe air-duct leakage
   - 5.4 identify the types of liners, dampers and louvres used in air-duct systems
   - 5.5 describe terminal air-distribution devices, including the principles of diffusion, induction, entrainment and aspiration

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6. describe the various types and operation of coils used in HVAC systems

6.1 explain how steam, hot-water and glycol coils are sized, configured and operated to reduce the chance of freezing

6.2 describe the installation recommendations for coils, piping, steam traps, control valves, air vents and vacuum-relief devices

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:

- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:

- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:

- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3043: ENVIRONMENTAL AND CONTROL SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operation and maintenance of different types of heating systems used in buildings and energy plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the components, operating principles and maintenance procedures of steam-heating systems**
   - 1.1 describe the construction and operation of steam-heating system devices used to transfer heat from the steam to a heated space
   - 1.2 describe the auxiliary equipment used in a steam-heating system, including air vents, radiator valves and traps and condensate-return equipment
   - 1.3 describe standard types of piping and equipment layout for steam-heating systems
   - 1.4 describe the general operation and maintenance of steam-heating systems
   - 1.5 explain typical problems and resolutions in the operation of steam-heating systems
2. **describe the various designs, equipment and operation of hot-water-heating systems**
   - 2.1 describe the standard piping and circulation layouts of hot-water-heating systems
   - 2.2 compare the advantages and disadvantages of hot-water- and steam-heating systems
   - 2.3 describe various types of special hot-water-heating systems
   - 2.4 describe the purpose and function of standard hot-water-heating system accessories
   - 2.5 explain how the location of the hot-water circulating pump and the expansion tank are determined
   - 2.6 describe the routine operation of hot-water-heating systems, including cleaning, filling and starting and the use of glycol
   - 2.7 explain typical problems and resolutions in the operation of steam-heating systems
3. **describe common heating systems encountered by power engineers**
   - 3.1 describe natural gas fueled warm-air-heating systems
   - 3.2 describe the recommended maintenance procedures for warm-air-heating and ventilating systems
   - 3.3 discuss the concept, application, construction and operation of infrared heaters
   - 3.4 discuss the different methods of electric heating and the advantages and disadvantages of electric-heating systems as compared to other types
4. **describe central, unitary and combined heating, ventilating and air conditioning (HVAC) systems**
   - 4.1 describe general layout and operation of unitary air-conditioning systems
   - 4.2 describe general layout and operation of central air-conditioning systems
   - 4.3 describe general layout and operation of combined air-conditioning systems
   - 4.4 discuss how HVAC systems should be operated under different situations

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5. describe heat gains and heat losses and common methods for energy recovery

5.1 define heat transmission terminology
5.2 describe heat gain and heat loss analysis in a building or energy plant
5.3 describe the general principles of HVAC heat recovery

6. describe the control systems strategies used in HVAC systems

6.1 describe a basic ventilation control strategy for HVAC systems
6.2 describe heating control strategies for HVAC systems
6.3 describe humidification, dehumidification and cooling control strategies for HVAC systems
6.4 describe volume control with static-pressure regulation for HVAC systems

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3044: INDUSTRIAL PLANT CONFIGURATIONS

Level: Advanced

Prerequisite: None

Description: Students will be able to identify steam-related processes employed by hydrocarbon-centric and common industrial plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify steam-related processes employed in hydrocarbon-centric plants**
   - 1.1 identify standard thermal system pathways and segments commonly used in plants
   - 1.2 identify equipment and processes in heat transfer fluid (HTF) heating systems
   - 1.3 identify the main thermal processes used in oil-refining industries
   - 1.4 describe the main processes used in steam-assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS)
   - 1.5 identify thermal processes used in gas separation and compression plants
2. **identify steam-related processes employed in common industrial plants**
   - 2.1 identify the main steam/boiler processes used in wood and biomass processing plants
   - 2.2 identify the important thermal processes used in food production and preservation
   - 2.3 identify the common processes and equipment used in metallurgical processing plants
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks
4. **create a transitional strategy to accommodate personal changes and build personal values**
   - 4.1 identify short-term and long-term goals
   - 4.2 identify steps to achieve goals

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COURSE PEN3605: PEN PRACTICUM 4A

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3610: PEN PRACTICUM 4B

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3615: PEN PRACTICUM 4C

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3620: PEN PRACTICUM 4D

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3400: SAFETY & CODES

Level: Advanced

Prerequisite: None

Description: Students will be able to discuss and describe fire safety, building safety, confined space entry and Workplace Hazardous Materials Information Systems (WHMIS) as well as demonstrate working knowledge of occupational health and safety legislation, provincial acts and regulations and codes for boilers from both the Canadian Standards Association (CSA) and the American Society of Mechanical Engineers (ASME) related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

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Resources: PanGlobal 5th class power engineering learning materials and workbooks

Note: This course may promote discussions around sensitive topics (e.g., injury and death) in the context of student safety with respect to workplace hazards.

Outcomes: The student will:

1. **discuss acceptable methods of extinguishing various classifications of fire and describe fire extinguishers and fire detection systems**
   - 1.1 explain the overall need for and the intent of fire protection standards, laws and regulations
   - 1.2 explain the different fire classifications, and describe the extinguishing methods for each
   - 1.3 explain the application and operation of standpipes, hoses and sprinklers in buildings
   - 1.4 explain the various types of fire and smoke detectors
   - 1.5 describe the operation, placement and maintenance of the common types of portable extinguishers
   - 1.6 discuss the need and use of a fire pump
2. **describe how a building operator can prevent accidental situations in order to protect the occupants of a facility**
   - 2.1 explain the personal safety responsibilities and precautions that must be applied by the building operator
   - 2.2 describe the general safety precautions required in the maintenance and operation of buildings
   - 2.3 identify common scenarios where the building operator can prevent accidents
   - 2.4 explain the importance of first aid and CPR training
3. **describe procedures needed to enter into or work safely in confined spaces**
   - 3.1 define confined space, list some confined spaces and describe the hazards of being in a confined space
   - 3.2 refer to local jurisdictional regulations, and describe procedures to follow when entering a confined space, including completion of an entry checklist
4. **describe the importance and structure of WHMIS**
   - 4.1 explain the meaning, enforcement and importance of WHMIS
   - 4.2 explain who is responsible for maintaining WHMIS records

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4.3 discuss workers' rights and responsibilities under WHMIS
4.4 explain what material safety data sheets (MSDS) consist of

5. discuss the provincial legislation addressing occupational health and safety (OHS)

5.1 explain the general intent of occupational health and safety
5.2 discuss some of the responsibilities, according to the *Occupational Health and Safety (OHS) Act*, of workers, employers and others related to health and safety
5.3 describe the conditions that must exist before a worker can refuse to work
5.4 identify and discuss jurisdictional regulations related to health and safety

6. discuss the purpose of the jurisdictional acts and regulations pertaining to the operation of boilers and pressure equipment

6.1 identify jurisdictional acts, and explain the purpose and scope of the regulations
6.2 explain the purpose and intent of the regulations governing the operation of boilers and pressure equipment
6.3 discuss the regulations relating to power engineering qualifications

7. demonstrate a working knowledge of the CSA and the ASME codes of concern to the 5th class power engineer

7.1 explain the content and use of the CSA-B51, Boiler, Pressure Vessel, and Pressure Piping Code
7.2 explain the content and use of the CSA-B52, Mechanical Refrigeration Code
7.3 explain the purpose of ASME Boiler and Pressure Vessel Code, Section I – Power Boilers
7.4 explain the purpose of ASME Boiler and Pressure Vessel Code, Section IV – Heating Boilers
7.5 explain the purpose of ASME Boiler and Pressure Vessel Code, Section VI – Recommended Rules for the Care and Operation of Heating Boilers
7.6 explain the purpose of ASME Boiler and Pressure Vessel Code, Section VII – Recommended Rules for the Care and Operation of Power Boilers

8. demonstrate basic competencies

8.1 demonstrate fundamental skills to:
- 8.1.1 communicate
- 8.1.2 manage information
- 8.1.3 use numbers
- 8.1.4 think and solve problems

8.2 demonstrate personal management skills to:
- 8.2.1 demonstrate positive attitudes and behaviours
- 8.2.2 be responsible
- 8.2.3 be adaptable
- 8.2.4 learn continuously
- 8.2.5 work safely

8.3 demonstrate teamwork skills to:
- 8.3.1 work with others
- 8.3.2 participate in projects and tasks

9. create a transitional strategy to accommodate personal changes and build personal values

9.1 identify short-term and long-term goals
9.2 identify steps to achieve goals

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COURSE PEN3405: APPLIED SCIENCE

Level: Advanced

Prerequisite: None

Description: Students will be able to perform simple calculations, complete arithmetic operations and define basic terms in the study of mechanics, as well as describe the principles of thermodynamics and modes of heat transfer related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **perform simple calculations involving System International (SI) units**
   - 1.1 list SI units and their symbols for length, mass, temperature and speed
   - 1.2 identify and list symbols for unit prefixes
   - 1.3 perform conversions between basic SI, imperial, standard (USCS) and US customary units
2. **perform basic arithmetic operations**
   - 2.1 perform basic arithmetic operations (addition, subtraction, multiplication and division) on whole numbers without the use of a calculator
   - 2.2 perform basic arithmetic operations on decimal numbers
   - 2.3 perform basic arithmetic operations on fractions
   - 2.4 reduce fractions to lowest terms
   - 2.5 convert fractions to decimals and decimals to fractions
   - 2.6 evaluate percentage problems
   - 2.7 determine the correct quantity of a substance when given a ratio
3. **transpose equations in order to find values for different variables in a formula**
   - 3.1 transpose commonly used equations involving up to two variables and all basic mathematical operations
   - 3.2 insert values into common equations and then solve the equations
4. **calculate the volumes of rectangular objects, cylinders, spheres and the surface areas of cylinders and spheres**
   - 4.1 state the SI units for area and volume
   - 4.2 calculate the surface area and volume of a rectangular tank
   - 4.3 calculate the surface area and volume of a cylinder
5. **define basic terms used in the study of mechanics**
   - 5.1 define force, velocity, mass, pressure, energy, work and power
   - 5.2 define the application of levers, pulleys and inclined planes
   - 5.3 define mechanical advantage

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6. explain the principles of thermodynamics and the modes of heat transfer

- 6.1 describe the three states of matter
- 6.2 describe the expansion of solids and liquids
- 6.3 explain the different temperature scales used in thermodynamics; i.e., Celsius and Fahrenheit
- 6.4 define sensible and latent heat
- 6.5 describe the three modes of heat transfer
- 6.6 explain the energy in the expansion of water to steam

7. demonstrate basic competencies

- 7.1 demonstrate fundamental skills to:
  - 7.1.1 communicate
  - 7.1.2 manage information
  - 7.1.3 use numbers
  - 7.1.4 think and solve problems
- 7.2 demonstrate personal management skills to:
  - 7.2.1 demonstrate positive attitudes and behaviours
  - 7.2.2 be responsible
  - 7.2.3 be adaptable
  - 7.2.4 learn continuously
  - 7.2.5 work safely
- 7.3 demonstrate teamwork skills to:
  - 7.3.1 work with others
  - 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

- 8.1 identify short-term and long-term goals
- 8.2 identify steps to achieve goals

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COURSE PEN3410: ELECTRICITY & WELDING

Level: Advanced

Prerequisite: None

Description: Students will be able to discuss the design and accessories of an electrical circuit, lighting systems and electric motors, as well as define welding terms and describe methods of weld inspection related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **discuss the design and accessories of an electrical circuit**
   - 1.1 explain electricity, electric circuits and voltage drop
   - 1.2 calculate current and power in an electric circuit
   - 1.3 estimate the cost of electrical power for a facility
   - 1.4 describe how to read a power meter
   - 1.5 describe circuit accessories, including switches, fuses, breakers and receptacles
   - 1.6 explain the danger of electric shock
2. **describe the design of lighting systems**
   - 2.1 explain what constitutes a good lighting system
   - 2.2 explain maintenance of lighting systems
   - 2.3 describe troubleshooting of incandescent and fluorescent lighting systems
3. **explain various lighting systems and basic design considerations for lighting a space**
   - 3.1 describe the common types of lighting equipment and systems
   - 3.2 explain the various methods of lighting control
   - 3.3 describe the general requirements and criteria for emergency lighting in buildings
   - 3.4 discuss the interrelationship between lighting, air conditioning and energy conservation in buildings
4. **describe and explain the function of various components of an electric control circuit**
   - 4.1 discuss various terms associated with electric control systems
   - 4.2 describe the basic construction and operation of
     - 4.2.1 electrical thermostats
     - 4.2.2 humidity controllers
     - 4.2.3 pressure controllers
   - 4.3 describe the function and operation of the controlled devices in electrical control systems
   - 4.4 explain the operating sequence of a basic electrical control circuit
5. **describe the design and troubleshooting of electric motors**
   - 5.1 describe simple electrical system problems, including short circuits, grounds and bad connections
   - 5.2 describe static electricity
   - 5.3 describe transformers and electric motors

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5.4 explain motor types and the bearing care and troubleshooting of those motors
5.5 explain the CSA approval and markings for electrical appliances

6. define welding terms and describe methods of weld inspection

6.1 define common terms used in welding
6.2 describe the jurisdictional requirements for a weld repair
6.3 explain the role of a building operator in preparing for a welder
6.4 discuss commonly used methods of weld inspection and testing

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3415: PLUMBING & PIPING

Level: Advanced

Prerequisite: None

Description: Students will be able to explain various water supply and drainage systems and describe the operating principles, design, construction, operation, troubleshooting and maintenance of piping, valves, steam traps and thermoil systems related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **explain the various water supply systems in a building**
   - 1.1. describe the cold-water distribution system in a building
   - 1.2. describe the hot-water distribution system in a building
   - 1.3. describe the construction and operation of hot-water heaters used in building systems
   - 1.4. explain what is meant by the term backflow prevention and describe the common methods used
   - 1.5. list and describe the construction and operation of protective devices for water systems used in buildings
2. **describe various sanitary-drainage systems employed with buildings**
   - 2.1 describe the overall layout of drainage systems for buildings
   - 2.2 describe stormwater-drainage systems for buildings
   - 2.3 list the steps to take in the routine maintenance of devices for sanitary-drainage systems used in buildings
   - 2.4 apply a troubleshooting guide for sanitary-drainage systems
3. **describe the various construction materials, size classifications and connection methods for the piping in a plant**
   - 3.1 explain the characteristics and applications of the various materials used to manufacture piping and fittings
   - 3.2 explain pipe-size schedules and classifications
   - 3.3 identify screwed-, flanged- and welded-pipe connections
4. **describe piping expansion, support and insulation**
   - 4.1 explain pipe expansion and the principle of expansion bends and joints
   - 4.2 explain the purpose of pipe supports, and describe various pipe support designs
   - 4.3 explain the purposes for pipe insulation
   - 4.4 describe the use of common insulation materials
5. **explain the purpose of steam traps and describe the installation and operating principles of the various steam traps found on piping systems**
   - 5.1 describe the design and operating principle of mechanical traps
   - 5.2 describe the design and operating principle of thermostatic steam traps

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5.3 describe the correct piping arrangement and procedures for a steam trap
5.4 explain the purpose and design of a strainer
5.5 explain the causes, effects and prevention of water hammer

6. describe the design, application and maintenance of common types of valves used in piping systems

6.1 describe the five standard valve designs:
- 6.1.1 gate
- 6.1.2 globe
- 6.1.3 butterfly
- 6.1.4 ball
- 6.1.5 plug

6.2 describe the design and operation of check and non-return valves
6.3 describe the function of a pressure-reducing valve
6.4 describe identification markings for valves
6.5 describe typical requirements for valve maintenance
6.6 describe the stop valves and drain connections on hot-water boilers

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3420: BOILER DETAILS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe and demonstrate an understanding and operation of the various types of boilers and name, identify and explain the operating principles of steam and hot-water boilers and boiler fittings related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the various types of water-tube boilers used in power and heating systems**
   - 1.1 describe the construction of water-tube and copper tubular boilers
   - 1.2 describe the water circulation in a longitudinal-drum straight-tube boiler
   - 1.3 describe four-drum, three-drum, and two-drum bent-tube boilers and the advantages of bent-tube boilers compared to straight-tube boilers
   - 1.4 describe the construction of the A-type, D-type and O-type and the advantages of packaged water-tube boilers
   - 1.5 describe the general design and construction of a typical large steam-generating unit
2. **describe and explain the uses of cast iron boilers**
   - 2.1 describe the general construction of cast iron sectional boilers
   - 2.2 list the advantages of cast iron section boilers over water-tube and fire-tube boilers
   - 2.3 describe the arrangement of equipment in a multiple cast iron sectional boiler heating plant
   - 2.4 describe the construction and operation of cast iron modular boilers
3. **describe the various types of fire-tube boilers used in power and heating systems**
   - 3.1 explain the difference between power and heating boilers
   - 3.2 describe the construction and application of the horizontal-return tubular, locomotive and firebox boilers
   - 3.3 describe the construction and application of wet-back and dry-back scotch boilers
   - 3.4 describe the construction and application of vertical fire-tube boilers used in heating-plant service
   - 3.5 describe the construction of packaged fire-tube boilers
4. **describe electric boilers with regard to their use and general design**
   - 4.1 compare electric boilers to fuel-fired boilers
   - 4.2 describe the construction and operating principle of electrode-type electric boilers
   - 4.3 describe the construction and operating principle of immersion-type electric boilers
5. **name, identify and explain the operating principles of the fittings for steam boilers**
   - 5.1 describe the construction, purpose and operation of pressure gauges and siphons
   - 5.2 describe the testing of pressure gauges
   - 5.3 describe the construction, operation, mounting and testing of safety valves

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5.4 describe the purpose, function and testing of gauge glasses and water columns
5.5 explain how to change a gauge glass
5.6 describe the construction, operation and purpose of the following valves:
    5.6.1 gauge glass safety-shutoff valves
    5.6.2 gauge glass quick-closing valves
    5.6.3 stop valves
    5.6.4 check valves
    5.6.5 blowoff (blow-down) valves
    5.6.6 vent valves

6. name, identify and explain the operating principles of the fittings for hot-water boilers

6.1 identify the operational fittings used in hot-water-heating boiler systems
6.2 explain the function of a pressure gauge
6.3 explain how to change a gauge glass
6.4 describe the operation of an auto-fill valve
6.5 list the types of optional fittings that are used in hot-water-heating boiler systems

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
    7.1.1 communicate
    7.1.2 manage information
    7.1.3 use numbers
    7.1.4 think and solve problems
7.2 demonstrate personal management skills to:
    7.2.1 demonstrate positive attitudes and behaviours
    7.2.2 be responsible
    7.2.3 be adaptable
    7.2.4 learn continuously
    7.2.5 work safely
7.3 demonstrate teamwork skills to:
    7.3.1 work with others
    7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3425: BOILER OPERATION

Level: Advanced

Prerequisite: None

Description: Students will be able to name, identify and explain the design and operation of fuel cut-off, feedwater, operating, combustion and programming controls, as well as describe the preparation, start-up, shutdown, abnormal conditions, routine operation checks and service and maintenance required for hot-water boilers related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **discuss the design, operation and testing of low-water fuel cut-off and describe feedwater control methods and devices used on low-pressure boilers**
   - 1.1 describe the construction and operation of float and electrode low-water-level fuel cut-off equipment
   - 1.2 describe the testing and maintenance of float and electrode low-water-level fuel cut-offs
   - 1.3 describe the operation of a feedwater float switch operating a valve and a float switch
   - 1.4 explain the purpose and function of piping connections used for heating boiler feedwater and condensate
2. **name and describe the various operating controls found on low-pressure boilers**
   - 2.1 describe the operation of the on-off control found on low-pressure steam boilers and hot-water boilers
   - 2.2 describe the operation of the high-low fire control found on low-pressure steam boilers and hot-water boilers
   - 2.3 describe the operation of the modulating control found on low-pressure steam boilers and hot-water boilers
   - 2.4 describe the operation of the high-limit control found on low-pressure steam boilers and hot-water boilers
   - 2.5 explain the operation of the common control switches found on a low-pressure boiler
   - 2.6 describe the operation of the safety switches found on the fuel supplies of low-pressure boilers
   - 2.7 explain the required testing and maintenance of controls on heating boilers
3. **explain the design and operation of various combustion controls on heating boilers**
   - 3.1 list and discuss the various types of flame-failure detectors on heating boilers
   - 3.2 describe the testing of flame-failure safety devices on heating boilers
4. **describe the basic operation of programming controls**
   - 4.1 describe the operation of equipment used to automatically start-up and shutdown boilers
   - 4.2 list a typical sequence of start-up and shutdown events
   - 4.3 describe common 5th class operator responses to a boiler programmer start-up or shutdown

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5. **describe the preparation, start-up and shutdown, abnormal conditions and routine operational checks in the operation of hot-water boilers**
   - 5.1 explain the preparation required before starting a steam or hot-water boiler
   - 5.2 explain the start-up steps once the boiler has been prepared
   - 5.3 state possible abnormal conditions during start-up, the cautions required to avoid uneven expansion and thermal shock
   - 5.4 describe the procedure required when cutting in an additional boiler
   - 5.5 describe the operating conditions for hot-water boilers and steam boilers that must be checked daily, and state the required monthly checks
   - 5.6 explain the procedure for removing a hot-water boiler from service
   - 5.7 describe the procedure for removing a steam boiler from service
   - 5.8 explain the emergency conditions that can occur during the operation of a steam boiler
   - 5.9 explain the causes and prevention of furnace and pressure explosions
   - 5.10 explain the reasons for boiler accidents, and describe the role and design of operation logs for safer usage of a boiler
   - 5.11 describe the traits required of a safe operator of boiler systems
6. **describe the service and maintenance required for boilers, the procedure for preparing boilers for inspection and cleaning and the cleaning methods for boilers**
   - 6.1 describe the general servicing and routine maintenance of packaged fire-tube and cast iron sectional boilers
   - 6.2 explain the importance of lay-ups and the procedures to be followed for wet- and dry-boiler lay-ups
   - 6.3 describe the symptoms of a leaking fire tube
   - 6.4 list the steps and precautions to be taken to prepare a boiler for inspection
   - 6.5 describe the inspection of a boiler
   - 6.6 describe the methods and tools used for mechanical cleaning of a boiler
7. **discuss the characteristics of common fuels used in heating boilers, conditions for complete and incomplete combustion, requirements for draft methods and the application of flue-gas analysis**
   - 7.1 explain natural and mechanical draft arrangements
   - 7.2 describe draft measurement using U-tube and inclined-draft gauges
   - 7.3 describe the usage, advantages and characteristics of common boiler fuels
   - 7.4 state the requirements and reactions for complete and incomplete combustion
   - 7.5 explain the difference between a pressure explosion and a furnace explosion
8. **describe the operation of the various types of gas and oil burners used on boilers**
   - 8.1 describe the operation of atmospheric and ring-gas burners
   - 8.2 describe the construction and operation of automatic valves
   - 8.3 describe the principal oil-atomizing burners for boilers
   - 8.4 list and describe the auxiliary equipment needed for an oil-combustion system
   - 8.5 describe the overall components and operation of fuel-oil systems
9. **demonstrate basic competencies**
   - 9.1 demonstrate fundamental skills to:
     - 9.1.1 communicate
     - 9.1.2 manage information
     - 9.1.3 use numbers
     - 9.1.4 think and solve problems

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9.2 demonstrate personal management skills to:
- 9.2.1 demonstrate positive attitudes and behaviours
- 9.2.2 be responsible
- 9.2.3 be adaptable
- 9.2.4 learn continuously
- 9.2.5 work safely

9.3 demonstrate teamwork skills to:
- 9.3.1 work with others
- 9.3.2 participate in projects and tasks

10. create a transitional strategy to accommodate personal changes and build personal values

10.1 identify short-term and long-term goals

10.2 identify steps to achieve goals

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COURSE PEN3430: HEATING SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operating principles, design, construction, operation, troubleshooting and maintenance of steam and hot-water-heating systems related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the various ways a building gains and loses heat**
   - 1.1 define heat-transmission terminology, and identify conversions or related units
   - 1.2 describe the heat gains that occur in a building due to conduction, infiltration, ventilation and radiation
   - 1.3 describe the heat gains that occur in a building due to people, lighting, electric motors, appliances and cooking
   - 1.4 describe the heat losses that occur in a building due to conduction, convection, radiation, infiltration and ventilation
2. **describe the operating principles of steam-heating equipment and components**
   - 2.1 describe the construction and operation of devices for steam-heating systems used to transfer heat from the steam to a heated space
   - 2.2 list and describe the auxiliary equipment used in a steam-heating system, including:
     - 2.2.1 air vents
     - 2.2.2 radiator valves and traps
     - 2.2.3 condensate-return equipment
3. **describe the operating principles and maintenance procedures of steam-heating systems and the components of these systems**
   - 3.1 describe standard types of piping and equipment layout for steam-heating systems
   - 3.2 describe the general operation and maintenance of steam-heating systems
   - 3.3 apply a troubleshooting guide for a steam-heating system
4. **describe the various designs of hot-water-heating systems**
   - 4.1 sketch and describe the standard piping and circulation layouts of hot-water-heating systems
   - 4.2 compare the advantages and disadvantages of hot-water- and steam-heating systems
   - 4.3 describe radiant panel and snow-melting hot-water systems

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5. describe accessories, operation and troubleshooting of a hot-water-heating system

5.1 describe the purpose and function of standard accessories for hot-water-heating systems, including:
- 5.1.1 diverter fittings
- 5.1.2 air vents
- 5.1.3 air separators
- 5.1.4 flow-control valves
- 5.1.5 balancing valves and fittings
- 5.1.6 riser-stop valves
- 5.1.7 pressure-reducing valves
- 5.1.8 circulating pumps
- 5.1.9 expansion tanks
- 5.1.10 steam-to-hot-water converters

5.2 explain how the location of the hot-water circulating pump and expansion tank are determined

5.3 describe the cleaning, filling, starting and routine operation of hot-water-heating systems

5.4 apply a troubleshooting guide for a hot-water-heating system

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals

7.2 identify steps to achieve goals

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COURSE PEN3435: HUMAN COMFORT

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operating principles, design, construction, operation, troubleshooting and maintenance of warm-air-heating systems; ventilation and filtration systems; infrared and electric heating systems; and humidification systems and processes related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the operating principles of warm-air heating sources**
   - 1.1 compare the advantages and disadvantages of forced and gravity warm-air systems
   - 1.2 list and describe the common sources of warm-air heat
   - 1.3 list and describe the operational characteristics of directly fired space heaters
2. **describe the components and maintenance requirements of typical warm-air heating and ventilation systems**
   - 2.1 describe the operation of furnace components, including both mechanical and electronic filters
   - 2.2 describe and discuss the relative merits of three types of air distribution and duct systems
   - 2.3 describe the recommended maintenance procedures for warm-air-heating and ventilating systems
   - 2.4 apply a troubleshooting guide for forced warm-air systems and components
3. **describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems**
   - 3.1 explain the difference between natural and mechanical ventilation
   - 3.2 describe the types of contaminants found in air
   - 3.3 describe the types of air-cleaning devices used in buildings
4. **describe infrared and electric heating systems**
   - 4.1 discuss the concept and application of infrared heating
   - 4.2 describe the construction and operation of gas-fired and electric heating elements used in infrared heaters
   - 4.3 list the advantages of electric heating systems compared to other types of heating systems
   - 4.4 describe the different methods of electric heating
5. **explain the equipment and the principles of humidification**
   - 5.1 explain the principles of humidification
   - 5.2 describe residential and commercial types of humidifiers
   - 5.3 describe industrial types of humidifiers
6. **describe and explain the function of various components of an electric control circuit**
   - 6.1 discuss the various terms associated with electric control systems
   - 6.2 describe the basic construction and operation of electrical thermostats
   - 6.3 describe the basic construction and operation of humidity controllers

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6.4 describe the basic construction and operation of pressure controllers
6.5 describe the function and operation of the controlled devices in electrical control systems
6.6 explain the operating sequence of a basic electrical control circuit

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3440: REFRIGERATION THEORY

Level: Advanced

Prerequisite: None

Description: Students will be able to explain refrigeration theory, refrigerant properties and the principles of compression refrigeration systems and the components of refrigeration compressors related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **explain the theory and terms associated with refrigeration**
   - 1.1 explain the fundamentals of refrigeration
   - 1.2 describe the actual cycle of operations in vapour-compression refrigeration systems
   - 1.3 state how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance
2. **describe the different refrigerants used and explain the various properties of these refrigerants**
   - 2.1 describe the identification and classification of refrigerants
   - 2.2 describe the characteristics and thermodynamic properties of refrigerants
   - 2.3 describe the physical properties of refrigerants
3. **describe the operating principles of compression refrigeration systems**
   - 3.1 describe the basic layout of compression refrigeration systems
   - 3.2 distinguish between direct and indirect refrigeration systems
   - 3.3 explain how compression refrigeration system temperatures and pressures are regulated
   - 3.4 describe the layout of packaged refrigeration systems and the role of a refrigeration economizer
4. **describe the operating principles and the components of refrigeration compressors and perform simple compressor calculations**
   - 4.1 describe the construction and operation of the following:
     - 4.1.1 reciprocating refrigeration compressor
     - 4.1.2 rotary refrigeration compressor
     - 4.1.3 centrifugal refrigeration compressor
     - 4.1.4 seals for refrigeration compressors
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems

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5.2 demonstrate personal management skills to:
    5.2.1 demonstrate positive attitudes and behaviours
    5.2.2 be responsible
    5.2.3 be adaptable
    5.2.4 learn continuously
    5.2.5 work safely
5.3 demonstrate teamwork skills to:
    5.3.1 work with others
    5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

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COURSE PEN3445: HEATING & COOLING

Level: Advanced

Prerequisite: None

Description: Students will be able to explain the design and construction of heat exchange systems, describe components used in refrigeration systems and demonstrate the operation and maintenance of cooling towers related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the different types of heat exchangers used in refrigeration systems**
   - 1.1 describe the designs and construction of evaporators use in refrigeration systems
   - 1.2 describe the designs and construction of condensers used in refrigeration systems
   - 1.3 discuss the operation and maintenance of refrigeration condensers
2. **describe the various accessories used in refrigeration systems**
   - 2.1 list and describe the operation of the gauges, separators, strainers and indicators used in refrigeration systems
3. **describe the operation and maintenance of cooling towers**
   - 3.1 list the factors that determine the rate of cooling in a cooling tower and the basic components for a cooling tower
   - 3.2 describe the construction and operation of a natural draft cooling tower
   - 3.3 describe the construction and operation of a mechanical draft cooling tower
   - 3.4 discuss cold-climate operation for cooling towers
   - 3.5 apply a troubleshooting guide for a cooling tower
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely
   - 4.3 demonstrate teamwork skills to:
     - 4.3.1 work with others
     - 4.3.2 participate in projects and tasks

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5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals

5.2 identify steps to achieve goals

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COURSE PEN3450: AC & REFRIGERATION

Level: Advanced

Prerequisite: None

Description: Students will be able to explain and describe the operation of various air-conditioning systems and the operating principles of metering devices, capacity controls and operational and safety controls on refrigeration systems as well as start-up procedures related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the operation of various air-conditioning systems**
   - 1.1 list the functional components and categories of air-conditioning systems
   - 1.2 describe the operation of air-handling units
   - 1.3 describe the general layout and operation of unitary air-conditioning systems
   - 1.4 describe the general layout and operation of central air-conditioning units
2. **describe the operating principles of refrigeration metering devices and capacity controls**
   - 2.1 describe the construction and operation of compression refrigeration cycle expansion valves
   - 2.2 describe the types of evaporator and compressor capacity controls
3. **describe the purposes and operating principles of the operational and safety controls on a refrigeration system**
   - 3.1 describe the operation of the various operating controls for refrigeration systems
   - 3.2 describe the actuators used in refrigeration controls systems
   - 3.3 describe the typical refrigeration system safety shutdown devices
4. **describe the various pre-start-up procedures used for compression refrigeration systems**
   - 4.1 describe how to perform refrigeration system leak tests
   - 4.2 describe how a refrigeration system is dried and charged prior to start-up
   - 4.3 describe how a refrigeration system is purged of non-condensable gases prior to start-up
   - 4.4 list the steps for adding oil to a refrigeration compressor when servicing the compressor
5. **describe the various operation and maintenance procedures used for compression refrigeration systems**
   - 5.1 describe the steps in the start-up and shutdown of a compression refrigeration system
   - 5.2 list the safety shutdown devices that are specific to centrifugal compressors
   - 5.3 describe the routine operation and associated log sheets for compression refrigeration systems
   - 5.4 list and describe the standard preventive maintenance procedures for compression refrigeration systems
   - 5.5 apply a troubleshooting guide for a compression refrigeration system

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6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:

- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:

- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:

- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals

7.2 identify steps to achieve goals

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COURSE PEN3455: PUMPS & COMPRESSION

Level: Advanced

Prerequisite: None

Description: Students will be able to explain the operating principles and maintenance procedures for different types of air compressors and pumps and be able to explain principles of lubrication and the simple care and maintenance of bearings related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

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Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **describe the various types of pumps found in buildings and industrial plants**
   - 1.1 list the common applications of pumps used in the power industry
   - 1.2 define the terms associated with pump performance
   - 1.3 sketch and describe the common types of pumps used in the power industry
2. **describe all details pertaining to pump operation and the various maintenance procedures performed on pumps**
   - 2.1 describe the construction and function of pump wear rings
   - 2.2 discuss pump shaft sealing, and describe the process that is followed when replacing compression-type packing
   - 2.3 sketch and describe the standard types of mechanical seals
   - 2.4 describe pump bearing and shaft alignment equipment and procedures
   - 2.5 describe pump start-up and priming procedures
   - 2.6 apply troubleshooting steps to a pump
3. **describe the importance and the principles of lubrication**
   - 3.1 discuss the concept of lubrication, and list the purposes of a lubricant
   - 3.2 list the various classes and types of lubricants, and describe their respective properties and application
   - 3.3 list the properties of lubricating oils and the additives used
4. **describe the methods for simple care and maintenance of bearings and their related lubrications systems**
   - 4.1 define boundary and full-fluid film lubrication
   - 4.2 sketch and describe shell bearings and sleeve bearings
   - 4.3 describe the construction and operation of thrust bearings
   - 4.4 describe how to clean and replace roller bearings and ball bearings
   - 4.5 list the causes of bearing failure
5. **describe the operating principles of the different types of air compressors**
   - 5.1 sketch and describe the main classifications and types of air compressors
   - 5.2 sketch and describe air compressor auxiliary equipment, including capacity control systems
   - 5.3 discuss preventive maintenance for reciprocating air compressors

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6. explain the design and application of basic therm-oil systems
- 6.1 describe the principle of therm-oil heating
- 6.2 describe a direct-heating therm-oil system
- 6.3 describe the design and operation of unfired steam-generating systems

7. describe the application and operation of microturbines
- 7.1 explain the application of a microturbine as a central heating plan (CHP)
- 7.2 explain the routine checks performed on a microturbine

8. describe the application and operation of internal combustion generators
- 8.1 explain start-up and shutdown procedures
- 8.2 explain the proper routine for pre-start and operational checks
- 8.3 identify the three methods of starting gen-sets

9. demonstrate basic competencies
- 9.1 demonstrate fundamental skills to:
  - 9.1.1 communicate
  - 9.1.2 manage information
  - 9.1.3 use numbers
  - 9.1.4 think and solve problems
- 9.2 demonstrate personal management skills to:
  - 9.2.1 demonstrate positive attitudes and behaviours
  - 9.2.2 be responsible
  - 9.2.3 be adaptable
  - 9.2.4 learn continuously
  - 9.2.5 work safely
- 9.3 demonstrate teamwork skills to:
  - 9.3.1 work with others
  - 9.3.2 participate in projects and tasks

10. create a transitional strategy to accommodate personal changes and build personal values
- 10.1 identify short-term and long-term goals
- 10.2 identify steps to achieve goals

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COURSE PEN3460: WATER TREATMENT

Level: Advanced

Prerequisite: None

Description: Students will be able to explain common external and internal water treatment methods including sampling, testing procedures and equipment related to 5th class power engineering.

Parameters: This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Resources: PanGlobal 5th class power engineering learning materials and workbooks

Outcomes: The student will:

1. **explain the purpose of the common external and internal water treatment methods**
   - 1.1 explain the four general sources of impurities in water, and describe the three general treatment methods
   - 1.2 explain the purpose of external filtration, and describe the design of pressure, filter-aid and cartridge filters
   - 1.3 explain boiler blowoff (blow down)
   - 1.4 describe the operating principles of a sodium zeolite water softener
   - 1.5 explain troubleshooting of and common operating problems associated with water softeners
   - 1.6 describe methods of feeding treatment chemicals into a boiler
   - 1.7 define potable water, and explain the importance of backflow prevention
   - 1.8 describe the testing of potable water
2. **explain general sampling and testing procedures and equipment, describe specific testing procedures and interpret test results for a boiler water treatment monitoring and testing program**
   - 2.1 list the flour classes of impurities and the three general treatment methods
   - 2.2 explain how to obtain a representative water sample
   - 2.3 discuss testing methods
   - 2.4 describe the principles and procedures to test for hardness, dissolved solids, molybdate and pH levels
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable

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3.2.4 learn continuously
3.2.5 work safely

3.3 demonstrate teamwork skills to:
3.3.1 work with others
3.3.2 participate in projects and tasks

4. create a transitional strategy to accommodate personal changes and build personal values

4.1 identify short-term and long-term goals
4.2 identify steps to achieve goals

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COURSE PEN3465: PEN PRACTICUM A

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 5th class power engineer credential offered by an agency external to the school.

This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3470: PEN PRACTICUM B

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 5th class power engineer credential offered by an agency external to the school.

This course can only be offered through a partnership (i.e., a memorandum of understanding) with a post-secondary institution that has received approval from Alberta Boilers Safety Association (ABSA) to provide instruction for a 5th class power engineer program. You can find a list of approved post-secondary institutions in the Power Engineering Program List.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3020: PREPARATORY MATH

Level: Advanced

Prerequisite: None

Description: Students will demonstrate fundamental mathematical concepts and skills required to perform calculations and computations.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform simple calculations using SI units**
   - 1.1 describe basic SI units, matching associated symbols for unit prefixes
   - 1.2 perform unit analyses in simple problems
   - 1.3 list derived SI units and their associated symbols
   - 1.4 perform conversions between SI and imperial units
2. **perform basic arithmetic operations**
   - 2.1 add and subtract integers
   - 2.2 multiply and divide whole numbers and decimal numbers
   - 2.3 perform arithmetic operations involving combinations of addition, subtraction, multiplication, division and powers in the proper order of operation
3. **perform basic arithmetic operations involving fractions, decimals and percentages**
   - 3.1 identify proper and improper fractions and mixed numbers
   - 3.2 add, subtract and multiply fractions and reduce them to lowest terms
   - 3.3 convert fractions to decimal numbers and decimal numbers to fractions
   - 3.4 analyze percentage problems
4. **explain the concepts of ratio and proportion**
   - 4.1 convert ratios of one quantity to another quantity
   - 4.2 solve word problems involving ratios and proportions
5. **identify values for different variables within a formula**
   - 5.1 solve equations and word problems
6. **describe measurement of length; define types of lines and angles; and calculate perimeters and areas of simple plane figures**
   - 6.1 convert measurement units from one system to another using linear measurement systems
   - 6.2 define parallel and perpendicular lines and types of angles
   - 6.3 describe types of simple plane figures, including area calculations for triangles and quadrilaterals
   - 6.4 describe the components of a circle and find its circumference, area and diameter
7. **calculate the volumes and surface areas of of rectangular objects, cylinders and spheres**
   - 7.1 convert commonly used volume units
   - 7.2 calculate the volume of a rectangular prism
   - 7.3 calculate the surface area and volume of a cylinder
   - 7.4 calculate the surface area and volume of a sphere

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8. demonstrate basic competencies

8.1 demonstrate fundamental skills to:

- 8.1.1 communicate
- 8.1.2 manage information
- 8.1.3 use numbers
- 8.1.4 think and solve problems

8.2 demonstrate personal management skills to:

- 8.2.1 demonstrate positive attitudes and behaviours
- 8.2.2 be responsible
- 8.2.3 be adaptable
- 8.2.4 learn continuously
- 8.2.5 work safely

8.3 demonstrate teamwork skills to:

- 8.3.1 work with others
- 8.3.2 participate in projects and tasks

9. create a transitional strategy to accommodate personal changes and build personal values

9.1 identify short-term and long-term goals

9.2 identify steps to achieve goals

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COURSE PEN3021: ELEMENTARY MECHANICS AND DYNAMICS

Level: Advanced

Prerequisite: None

Description: Students will be able to solve problems related to force, work, pressure, stress and friction.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform basic calculations and define basic terms used in the study of mechanics**
   - 1.1 define mass, force, acceleration, velocity and weight
   - 1.2 perform simple calculations involving force, pressure, work, power and energy
2. **perform calculations using forces and moments and determine whether or not a system is in equilibrium**
   - 2.1 define the moment of a force and its units
   - 2.2 determine the direction and magnitude of the moment of a force
3. **define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency**
   - 3.1 define the term simple machine
   - 3.2 calculate mechanical advantage, velocity ratio and efficiency of simple machines
4. **define and identify scalar and vector quantities and solve simple vector problems graphically**
   - 4.1 define scalar and vector quantities as they apply to drawing vector diagrams
5. **solve simple problems involving linear velocity, time and distance**
   - 5.1 solve distance, displacement, speed and velocity problems
   - 5.2 draw graphs of velocity as a function of time
   - 5.3 define acceleration, state its units and solve simple acceleration problems
   - 5.4 apply mathematical formulae relating acceleration, velocity, distance and time to solve problems
6. **perform calculations involving force, work, pressure, power and energy**
   - 6.1 perform calculations involving force and work
   - 6.2 perform calculations involving gauge, atmospheric pressure and absolute pressure
   - 6.3 perform calculations involving power and different forms of mechanical energy
7. **solve problems involving friction**
   - 7.1 apply the laws governing the types of friction
   - 7.2 apply the coefficient of friction to problems involving forces on a horizontal plane
8. **explain physical properties of materials and how their behaviour is affected when external forces are applied**
   - 8.1 describe the characteristics of materials, including elasticity, stiffness, plasticity, ductility, toughness, brittleness and hardness
   - 8.2 calculate stress including tensile, compressive and shear stresses within rigid body members due to external loads
   - 8.3 calculate the strain of members under load

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9. perform calculations pertaining to common power transmission systems

9.1 calculate pulley speeds, transmitted power and efficiency of belt drive systems

9.2 calculate gear speeds for gear and chain drive systems

10. demonstrate basic competencies

10.1 demonstrate fundamental skills to:

- 10.1.1 communicate
- 10.1.2 manage information
- 10.1.3 use numbers
- 10.1.4 think and solve problems

10.2 demonstrate personal management skills to:

- 10.2.1 demonstrate positive attitudes and behaviours
- 10.2.2 be responsible
- 10.2.3 be adaptable
- 10.2.4 learn continuously
- 10.2.5 work safely

10.3 demonstrate teamwork skills to:

- 10.3.1 work with others
- 10.3.2 participate in projects and tasks

11. create a transitional strategy to accommodate personal changes and build personal values

11.1 identify short-term and long-term goals

11.2 identify steps to achieve goals

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COURSE PEN3022: CHEMISTRY AND THERMODYNAMICS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe and define physical and chemical systems and explain how atoms and molecules combine to form compounds, mixtures and solutions. They will be able to apply thermodynamic principles to determine the state of a working fluid and describe how its properties (e.g., temperature, pressure, specific volume and enthalpy) explain its behaviour in specific processes.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify basic types of matter, their properties and the associated chemical principles**
   - 1.1 differentiate among the physical states of matter
   - 1.2 differentiate between chemical and physical changes in matter
   - 1.3 classify matter as either a type of mixture or a pure substance
   - 1.4 describe the purpose and uses of the periodic table using the parts of an atom
   - 1.5 describe the three main ways atoms bond together: covalent, ionic and metallic bonding
   - 1.6 discuss chemical equations and their purpose
   - 1.7 perform simple stoichiometric calculations
   - 1.8 demonstrate how unstable compounds are combined to make stable compounds
2. **explain the principles and laws of thermodynamics**
   - 2.1 define the first two laws of thermodynamics
   - 2.2 define heat and specific heat
   - 2.3 perform sensible heat calculations
   - 2.4 describe the expansion of solids and liquids
3. **explain the modes of heat transfer and the theory of heat-exchanger operation**
   - 3.1 describe the three modes of heat transfer with reference to heat exchangers
   - 3.2 discuss the general design and construction of typical heat exchangers
   - 3.3 describe heat transfer fluids and how they affect the operation of a heat exchanger, including fouling, leakage and vapour locking
   - 3.4 describe heat-exchanger inspection, maintenance and operation, including placing heat exchangers in service and removing them from service
4. **apply the thermodynamic principles through practical applications using the steam tables and the temperature-enthalpy chart**
   - 4.1 describe heat as it relates to steam, water and ice
   - 4.2 explain the various columns of the steam tables
   - 4.3 explain the thermodynamic principles of steam, using the steam tables

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5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:

- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:

- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:

- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals

6.2 identify steps to achieve goals

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COURSE PEN3023: POWER ENGINEERING GOVERNANCE

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the profession of the power engineer and the importance of jurisdictional regulations, codes and standards.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the power engineer profession**
   - 1.1 describe steam, its uses and the basic steam cycle
   - 1.2 describe the role and duties of a power engineer
   - 1.3 describe how shift work affects sleep patterns, diet and overall health
2. **describe the application of jurisdictional acts and regulations with respect to power engineers, boilers and pressure vessels**
   - 2.1 describe how the power engineering profession is regulated in Canada
   - 2.2 explain the purpose and scope of jurisdictional acts and regulations pertaining to power engineering and pressure equipment
   - 2.3 explain the purpose and intent of the regulations governing power engineers and pressure welders
3. **describe the purpose of boiler and pressure vessel codes and standards**
   - 3.1 discuss the history of how codes and standards became necessary in the pressure-equipment field
   - 3.2 explain the content and use of the *CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code*
   - 3.3 explain the content and use of the *CSA B52 Mechanical Refrigeration Code*
   - 3.4 explain the content and use of *ASME Boiler and Pressure Vessel Code* (*ASME BPVC*) Section I—Power Boilers
   - 3.5 explain the content and use of *ASME BPVC* Section VII—Recommended Guidelines for the Care of Power Boilers
   - 3.6 explain the content and use of *ASME BPVC* Section IV—Rules for Construction of Heating Boilers
   - 3.7 explain the content and use of *ASME BPVC* Section VI—Recommended Rules for the Care and Operation of Heating Boilers
   - 3.8 explain the purpose, intent and limitation of *ASME CSD-1 (Controls and Safety Devices for Automatically Fired Boilers) Standard*
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems

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4.2 demonstrate personal management skills to:
    4.2.1 demonstrate positive attitudes and behaviours
    4.2.2 be responsible
    4.2.3 be adaptable
    4.2.4 learn continuously
    4.2.5 work safely
4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3024: PLANT AND FIRE SAFETY

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the elements of maintaining a safe work environment, including fire safety and using and maintaining fire extinguishing equipment.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe general plant safety as it relates to power engineers**
   - 1.1 discuss the cost and effects of workplace accidents
   - 1.2 describe the basic hazards that may be in an energy plant and the basic personal protective equipment that may be required
   - 1.3 define, give examples of and describe common powerhouse hazards
   - 1.4 describe industrial health and safety management systems
   - 1.5 describe hazard assessment and control programs
2. **describe common safety programs generally applied in plants**
   - 2.1 describe common occupational health and safety (OH&S) programs found in most plants
   - 2.2 describe industrial safety training programs in which power engineers may require additional training
   - 2.3 discuss safe work permits
   - 2.4 describe methods of equipment isolation and lockout
3. **describe the policies and procedures for safe storage and handling of dangerous materials**
   - 3.1. discuss the WHMIS system
   - 3.2. discuss the essential components required in the WHMIS system
   - 3.3. describe the safe handling and use of gas cylinders in an energy plant (power plant)
   - 3.4. discuss the safe handling of hydrocarbons
4. **explain fire safety in an industrial plant**
   - 4.1 discuss the theory, terminology and the life safety issues associated with fires
   - 4.2 explain the five classes of fires and describe the types of fire extinguishing media and how they act on these fires
   - 4.3 explain fire prevention methods for the five classes of fires
5. **describe typical fire extinguishing equipment and its operation in plant environments**
   - 5.1 describe the construction and operation of various types of portable fire extinguishers
   - 5.2 discuss the inspection and maintenance requirements for portable fire extinguishers
   - 5.3 describe the types, layout and operation of standpipe and sprinkler systems
   - 5.4 discuss the maintenance requirements of standpipe and sprinkler system components
   - 5.5 describe the purpose, operation and maintenance of fire pumps

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6. demonstrate basic competencies

- 6.1 demonstrate fundamental skills to:
  - 6.1.1 communicate
  - 6.1.2 manage information
  - 6.1.3 use numbers
  - 6.1.4 think and solve problems
- 6.2 demonstrate personal management skills to:
  - 6.2.1 demonstrate positive attitudes and behaviours
  - 6.2.2 be responsible
  - 6.2.3 be adaptable
  - 6.2.4 learn continuously
  - 6.2.5 work safely
- 6.3 demonstrate teamwork skills to:
  - 6.3.1 work with others
  - 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

- 7.1 identify short-term and long-term goals
- 7.2 identify steps to achieve goals

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COURSE PEN3025: ENVIRONMENTAL IMPACT

Level: Advanced

Prerequisite: None

Description: Students will be able to identify environmental considerations for reducing or eliminating energy plant emissions.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify environmental considerations and how they relate to an operating plant**
   - 1.1 describe four important biogeochemical cycles that operate within the environment: oxygen, water, carbon and soil cycles
   - 1.2 describe typical interdependencies seen among elements within an ecosystem
   - 1.3 list the types of impacts that operating facilities can have on the environment
   - 1.4 describe the alert processes related to environmental problems of plants
   - 1.5 explain the importance of attitude in limiting the environmental impacts of plants
   - 1.6 describe the long-term environmental impacts that remain after the decommissioning and abandonment of plants
2. **explain how gas and noise emissions affect plant operations**
   - 2.1 identify the sources and effects of common gases and vapours that have an adverse environmental impact
   - 2.2 identify the common greenhouse- and acid-rain-causing gases and describe their effects
   - 2.3 describe the common methods for monitoring and reducing gaseous pollutants
   - 2.4 describe the effects of noise pollution and methods of identifying, measuring and controlling noise pollution
3. **explain how liquid and solid emissions affect plant operation**
   - 3.1 describe the sources and effects of solid pollutants from energy plants
   - 3.2 describe the theory of operation of separators/collectors and monitoring of flue-gas particulates
   - 3.3 describe the disposal methods of solid waste from energy plants
   - 3.4 list sources and effects of liquid waste and thermal pollution
   - 3.5 describe the preventive measures that can be taken to prevent liquid and thermal pollution
   - 3.6 describe methods of liquid waste disposal
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible

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4.2.3 be adaptable
4.2.4 learn continuously
4.2.5 work safely

4.3 demonstrate teamwork skills to:
4.3.1 work with others
4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3026: MATERIAL SCIENCE AND WELDING

Level: Advanced

Prerequisite: None

Description: Students will be able to describe properties of engineering materials, as well as welding processes and testing methods.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the mechanical properties of engineering materials**
   - 1.1 describe the mechanical properties of materials
   - 1.2 describe the various types of ferrous materials
   - 1.3 describe the various types of nonferrous materials
2. **describe welding processes relevant to the plant and power engineering**
   - 2.1 describe the non-fusion welding process, equipment used and methods
   - 2.2 describe forge and oxyfuel fusion welding processes and cutting processes
   - 2.3 describe metal arc welding processes
   - 2.4 describe heat treatment of welds
   - 2.5 describe the types of weld joints used in pressure-vessel construction
   - 2.6 describe the additional construction components required for pressure vessels to ensure structural integrity and access
3. **describe inspection processes and testing methods for welds and materials**
   - 3.1 describe common weld defects
   - 3.2 describe the process of visual testing of welds
   - 3.3 describe the process of penetrant testing for detecting weld or material defects
   - 3.4 describe the process of radiographic weld testing
   - 3.5 describe the process of ultrasonic weld testing
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely
   - 4.3 demonstrate teamwork skills to:
     - 4.3.1 work with others

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4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals

5.2 identify steps to achieve goals

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COURSE PEN3027: FLUID-HANDLING TECHNOLOGY

Level: Advanced

Prerequisite: None

Description: Students will be able to describe piping materials and methods, as well as the design, use and maintenance of valves.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the basic types of piping, piping connections, supports and drainage devices used in industry**
   - 1.1 state the applications for the most common materials
   - 1.2 identify the sizes of commercial pipe
   - 1.3 describe methods of connection for screwed, flanged and welded pipe
   - 1.4 identify pipefittings and their markings
   - 1.5 describe methods and devices used to allow for pipe expansion and support
   - 1.6 explain the methods used to promote good drainage of steam pipes, including the installation and maintenance of steam traps to reduce the effects of water hammer
   - 1.7 explain the requirements, materials used and methods for insulating pipe
2. **describe the design and operation of the valves most commonly used in industry and on boilers**
   - 2.1 describe standard valve designs
   - 2.2 describe the design and operation of specialized boiler valves
   - 2.3 describe a typical steam pressure reducing station and the design and operation of steam system pressure-reducing valves
   - 2.4 discuss valve details, including construction materials and identification markings
   - 2.5 describe typical valve maintenance requirements
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks

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4. create a transitional strategy to accommodate personal changes and build personal values

4.1 identify short-term and long-term goals

4.2 identify steps to achieve goals

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COURSE PEN3028: ELECTROTECHNOLOGY

Level: Advanced

Prerequisite: None

Description: Students will be able to apply the concepts of basic electricity and magnetism to the operation of AC and DC motors, generators and transformers. Students will be able to describe the power distribution system used for power plant operation.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **apply the concepts of basic electricity while performing simple calculations using voltage, current, resistance and power**
   - 1.1 describe the atomic structure of matter and its relationship to electricity
   - 1.2 describe basic electrical circuits
   - 1.3 state Ohm's Law and apply it to single resistor circuits
   - 1.4 apply Ohm's Law to series resistance circuits
   - 1.5 apply Ohm's Law to parallel resistance circuits
   - 1.6 explain electrical conductors and insulators using examples
   - 1.7 explain the factors that affect resistance mathematically
   - 1.8 calculate the power developed in an electrical circuit
2. **describe the basic principles of magnetism**
   - 2.1 describe electrical meters and their uses
   - 2.2 describe how voltage, current and resistance are measured in an electric circuit
   - 2.3 describe the construction and operation of a kilowatt hour meter
3. **describe the operating principles of the various types of AC and DC motors and generators**
   - 3.1 describe the construction and operation of DC generators and motors
   - 3.2 describe the construction and operation of AC generators (alternators) and motors
   - 3.3 interpret the information on a motor nameplate
   - 3.4 perform basic calculations relating to power factor and power factor correction
4. **describe the operating principles of electrical transformers**
   - 4.1 describe the principle of operation of transformers
   - 4.2 perform basic transformer calculations as they relate to the construction and operation of single-phase transformers
   - 4.3 describe the construction and operation of three-phase transformers
   - 4.4 discuss special types of transformers and their applications
   - 4.5 discuss cooling, safety and maintenance of transformers
5. **describe an electrical distribution system**
   - 5.1 list and describe the standard types of electrical voltage systems
   - 5.2 interpret electrical single-line diagrams and circuit symbols
   - 5.3 describe the major components of an electrical distribution system

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5.4 describe the function and operation of fuses and circuit breakers
5.5 describe the function and operation of alternate power supply system equipment

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3029: INSTRUMENTATION AND CONTROLS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the purpose, function and operation of energy plant instrumentation systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the overall purpose and function of plant instrumentation systems**
   - 1.1 describe the concept and basic components of a control loop
   - 1.2 describe the various means by which control signals are transmitted and the function of transducers
   - 1.3 list and describe the types of instruments that are not control-loop components
2. **describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity and composition**
   - 2.1 describe the types of pressure-sensing and measuring devices
   - 2.2 describe the types of level-sensing and measuring devices
   - 2.3 describe the types of flow-sensing and measuring devices
   - 2.4 describe the types of temperature-sensing and measuring devices
   - 2.5 describe the types of humidity-sensing and measuring devices
   - 2.6 describe the types of gas-sensing (composition) and measuring devices
3. **describe the basic types and functions of transmitters, recorders, controllers and control actuators**
   - 3.1 describe the construction and operational principles of instrumentation transmitters
   - 3.2 describe the construction and operational principles of instrumentation indicators and recorders
   - 3.3 describe the construction and operational principles of instrumentation controllers
   - 3.4 describe the construction and operational principles of final control elements
4. **describe the operation of programming controls for boilers, including applicable testing and maintenance procedures**
   - 4.1 discuss how programmable controllers work and how they act as sequencers for equipment
   - 4.2 describe applications of programmable controllers
   - 4.3 explain the HMI (human-machine interface) and the purpose of touchscreen displays, functions and alarm-handling
5. **describe the design and operation of electronic control systems**
   - 5.1 discuss electronic process control systems
   - 5.2 describe computers and how they operate within control systems
   - 5.3 describe the applications of computerized control systems and plant computers

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6. describe the design and operation of electrical control systems

6.1 describe the basic construction and operation of various components of electrical control systems

6.2 describe the function of control devices in electrical control systems

6.3 explain the operating sequence of basic electrical control circuits

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:

- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:

- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:

- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3030: INDUSTRIAL COMMUNICATION

Level: Advanced

Prerequisite: None

Description: Students will be able to interpret and sketch plant drawings and diagrams.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **create engineering equipment sketches**
   - 1.1 create sketches using centre lines and dimensioning
   - 1.2 recognize standard views of an object
   - 1.3 recognize cross-hatching methods in sectional drawings
   - 1.4 identify common drawing symbols and lines used in plant system trace drawings
   - 1.5 complete a plant trace drawing
2. **identify common types of diagrams used in plants**
   - 2.1 explain the layout of a plant diagram
   - 2.2 explain the use of a process flow diagram (PFD)
   - 2.3 explain the use of a piping and instrumentation diagram (P&ID)
   - 2.4 explain the use of general arrangement, a block plan and an equipment diagram
3. **describe the types and proper usage of plant communication systems**
   - 3.1 discuss effective written and verbal communication skills, including the use of two-way radios
   - 3.2 describe the legal documentation requirements for power engineers, including log books and log sheets
   - 3.3 discuss the elements of maintenance management systems, including work requests and work orders
   - 3.4 discuss the purpose, revision and control of standard operating procedures
   - 3.5 discuss updating procedures for a piping and instrumentation diagram
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously
     - 4.2.5 work safely

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4.3 demonstrate teamwork skills to:
    4.3.1 work with others
    4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals
5.2 identify steps to achieve goals

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COURSE PEN3031: BOILER DESIGNS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the design, components, construction, characteristics and operation of various types of boilers.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the historical development of boilers, boiler design, components and configuration**
   - 1.1 describe the history of boiler applications, design and modern boiler improvements
   - 1.2 describe packaged boilers
   - 1.3 describe the construction of field-assembled and field-erected boilers
   - 1.4 describe components and design aspects common to all boiler vessels
2. **describe the design, components and characteristics of fire-tube boilers**
   - 2.1 differentiate the scotch boiler from the other fire-tube boilers and describe the scotch boiler's development history
   - 2.2 describe circulation patterns in fire-tube boilers
   - 2.3 discuss construction details of fire-tube boilers
3. **describe the design, components and characteristics of water-tube boilers**
   - 3.1 describe the design and operating principles of water-tube boilers
   - 3.2 describe water-tube boiler components
   - 3.3 explain the design and application of packaged water-tube boilers
   - 3.4 describe the design, construction and components of large-scale steam-generating units
4. **explain the general design and application of electric boilers**
   - 4.1 discuss the advantages and disadvantages of electric boilers
   - 4.2 describe the construction and operating principle of electric boilers
5. **describe the special design considerations of boilers used in heating plants**
   - 5.1 describe the design of water-tube and coil-tube heating boilers
   - 5.2 describe cast iron boilers and vertical fire-tube boilers
   - 5.3 describe the construction and application of fire-tube heating boiler designs
6. **differentiate between power boilers and heating boilers**
   - 6.1 discuss the differences between power boiler and heating boiler design and installation
   - 6.2 discuss the differences between power boiler and heating boiler operation
7. **demonstrate basic competencies**
   - 7.1 demonstrate fundamental skills to:
     - 7.1.1 communicate
     - 7.1.2 manage information
     - 7.1.3 use numbers
     - 7.1.4 think and solve problems

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7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3032: BOILER SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the systems used in the operation and maintenance of boiler systems (e.g., combustion, fuel, draft, feedwater, blowoff and blowdown and fireside cleaning).

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the basic theory of combustion and the equipment used to provide proper combustion conditions within a boiler**
   - 1.1 discuss combustion, combustion equations and the relationship between theoretical and excess air
   - 1.2 discuss the characteristics of solid, liquid and gaseous fuels
   - 1.3 explain fuel and the effects of combustion on refractory materials
2. **describe common fuel systems found in boiler systems**
   - 2.1 describe solid-fuel delivery systems
   - 2.2 describe the main types of solid-fuel firing systems
   - 2.3 describe gaseous-fuel delivery systems
   - 2.4 describe the main types of gaseous-fuel firing systems
   - 2.5 describe liquid-fuel delivery systems
   - 2.6 describe the main types of liquid-fuel firing systems
   - 2.7 describe flue-gas analysis and how it relates to boiler efficiency
3. **describe basic concepts and equipment used to supply combustion air to boiler furnaces**
   - 3.1 describe the various air streams that deliver combustion air to a furnace
   - 3.2 relate differential pressure to the creation of draft
   - 3.3 describe forced, induced and balanced mechanical draft
   - 3.4 discuss common methods of controlling combustion airflow
   - 3.5 discuss common methods of measuring furnace pressures
4. **describe feedwater systems used with boilers**
   - 4.1 describe the overall layout of feedwater, condensate and make-up of water systems
   - 4.2 describe the valves used in feedwater systems
   - 4.3 describe the control strategies for single-element, two-element and three-element boiler feedwater systems
   - 4.4 describe methods of supplying feedwater to steam-heating boilers
   - 4.5 explain the operation of condensate receiver make-up water controls
   - 4.6 describe the return of condensate and the supply of feedwater to high-pressure boilers

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5. describe the purpose, equipment and operation of blowdown in boiler systems

5.1 describe blowoff, blowoff equipment and blowoff procedures
5.2 describe continuous blowdown, blowdown equipment and blowdown procedures
5.3 describe the maintenance and repair of blowoff systems

6. describe types of boiler fireside cleaning equipment, their purpose and their operation

6.1 describe common options for in-service fireside cleaning
6.2 describe the construction and operation of retractable soot blowers
6.3 describe the construction and operation stationary soot blowers
6.4 describe shot cleaning methods

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3033: LUBRICATION AND BEARINGS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the purpose and properties of lubrication for the maintenance and care of bearing systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the importance of lubrication and the principles concerned with lubrication**
   - 1.1 discuss the concept of lubrication
   - 1.2 list the purposes of a lubricant
   - 1.3 list the various classes and types of lubricants
   - 1.4 describe the properties and application of lubricants
   - 1.5 list the properties of lubricating oils, the additives used and their selection criteria
2. **describe bearing types, methods for care and maintenance of bearings and bearing lubrication systems**
   - 2.1 define boundary lubrication and full fluid-film lubrication
   - 2.2 describe shell (sleeve) bearings
   - 2.3 describe the construction and operation of antifriction bearings and thrust bearings
   - 2.4 describe how to clean and replace roller- and ball-type bearings
   - 2.5 explain the causes of bearing failure
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks
4. **create a transitional strategy to accommodate personal changes and build personal values**
   - 4.1 identify short-term and long-term goals
   - 4.2 identify steps to achieve goals

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COURSE PEN3034: PUMPS AND COMPRESSORS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operation and maintenance of various types of pumps and compressors used in power plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the construction and operating principles of various types of pumps used in power plants**
   - 1.1 list the common pump applications
   - 1.2 define the terms associated with pump performance
   - 1.3 describe the common pumps found in power plants
2. **describe the major considerations and procedures for pump operation and maintenance**
   - 2.1 discuss the components of a motor and a pump assembly
   - 2.2 describe the types of shaft seals
   - 2.3 describe standard types of mechanical seals
   - 2.4 describe pump-bearing and shaft-alignment equipment and procedures
   - 2.5 describe centrifugal pump start-up and priming procedures
   - 2.6 describe positive-displacement pump priming, start-up and routine
3. **describe the operating principles of the different types of compressors**
   - 3.1 describe the main classifications and types of compressors
   - 3.2 describe gaseous compression systems
4. **describe the major considerations and general procedures for compressor operation and maintenance**
   - 4.1 describe compressor parts and auxiliary equipment
   - 4.2 describe the construction and operation of seals for compressors
   - 4.3 describe the capacity control of compressors
   - 4.4 describe preventive maintenance and routine procedures for compressors
5. **demonstrate basic competencies**
   - 5.1 demonstrate fundamental skills to:
     - 5.1.1 communicate
     - 5.1.2 manage information
     - 5.1.3 use numbers
     - 5.1.4 think and solve problems
   - 5.2 demonstrate personal management skills to:
     - 5.2.1 demonstrate positive attitudes and behaviours
     - 5.2.2 be responsible
     - 5.2.3 be adaptable
     - 5.2.4 learn continuously

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5.2.5 work safely

5.3 demonstrate teamwork skills to:

5.3.1 work with others

5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals

6.2 identify steps to achieve goals

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COURSE PEN3035: BOILER SAFETY DEVICES

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the safety requirements, equipment and controls related to the safe operation of boilers.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the code requirements, design and operation of pressure relief valves for power boilers, heating boilers and pressure vessels**
   - 1.1 discuss the code requirements, construction and operation of ASME Section I pressure relief valves and devices
   - 1.2 discuss the code requirements, construction and operation of ASME Section IV pressure relief valves and devices
   - 1.3 describe the testing and repair of pressure relief valves
   - 1.4 describe the construction and operation of a temperature (temperature and pressure) relief device
2. **explain the design and operation of combustion safety controls on burners and boilers**
   - 2.1 describe basic boiler control systems
   - 2.2 compare the devices/controls that can be either operating or safety circuits
   - 2.3 describe a burner management system (BMS)
   - 2.4 describe the equipment operation process used to start-up and shutdown boilers
   - 2.5 interpret burner operating sequence bar graphs
   - 2.6 provide a typical sequence of start-up and shutdown events
   - 2.7 describe the construction and operation of burner/boiler flame failure detectors
   - 2.8 identify testing requirements for burner/boiler flame failure safety devices
3. **describe feedwater safety devices and control methods used on boilers**
   - 3.1 describe the construction and operation of boiler low-water-level fuel-cutoff equipment
   - 3.2 list the ASME and CSA code regulations regarding low-water fuel-cutoff devices
   - 3.3 describe testing and maintenance of boiler low-water-level fuel cutoffs
   - 3.4 describe direct- and indirect-type water-level indicators
4. **relate the operation and required fittings described in the code to the operating principles of fittings found on boilers**
   - 4.1 explain the code references for boiler fittings
   - 4.2 describe the code requirements for pressure gauges on steam boilers
   - 4.3 describe the code requirements for boiler connections and valves on steam boilers
   - 4.4 describe the code requirements for required fittings on hot-water boilers
   - 4.5 describe types of non-code required fittings used on boilers
   - 4.6 describe the trim items found on power and heating boilers

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5. describe the operating and safety controls found on boilers

5.1 discuss various operating controls for steam boilers and hot-water boilers
5.2 describe the safety controls found on boiler and burner systems
5.3 describe the operation of control and safety devices found on the fuel supplies of boilers
5.4 describe testing and maintenance requirements for boiler controls

6. demonstrate basic competencies

6.1 demonstrate fundamental skills to:
- 6.1.1 communicate
- 6.1.2 manage information
- 6.1.3 use numbers
- 6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
- 6.2.1 demonstrate positive attitudes and behaviours
- 6.2.2 be responsible
- 6.2.3 be adaptable
- 6.2.4 learn continuously
- 6.2.5 work safely

6.3 demonstrate teamwork skills to:
- 6.3.1 work with others
- 6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3036: BOILER PLANT OPERATION AND MANAGEMENT

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operational procedures for start-up, operation, management and shutdown of boiler plant systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe operational procedures related to start-up of auxiliary equipment in a boiler plant**
   - 1.1 describe the basic auxiliaries that need to be checked, prepared or placed in service before starting a boiler plant
   - 1.2 describe the general procedures for starting a plant for the first time or restarting after an outage or turnaround
   - 1.3 discuss basic operating practices for starting pumps and fans
   - 1.4 describe the general preparation for a hot-water boiler start-up
   - 1.5 describe the general preparation for a steam boiler start-up
   - 1.6 describe the safety and housekeeping preparation requirements for boiler plant start-up
2. **describe procedures for safely starting boiler systems**
   - 2.1 describe operation considerations when warming a cold boiler
   - 2.2 describe how to start and cut in a hot-water boiler
   - 2.3 describe how to start a single-boiler steam plant
   - 2.4 describe how to cut in a steam boiler in a multiple-boiler plant
   - 2.5 describe semi-automatic burner ignition systems
   - 2.6 discuss the post start-up inspection for boilers returning to service after a major outage
3. **describe operational procedures related to operating boilers**
   - 3.1 describe the operation of a hot-water boiler under routine conditions
   - 3.2 describe routine steam boiler operating duties
   - 3.3 describe emergency conditions in boiler plants and the required responses
   - 3.4 describe troubleshooting activities for basic boilers
4. **describe operational checks for operating boiler plants**
   - 4.1 describe the shift-based operator responsibilities for boiler plants
   - 4.2 describe the safety device operational checks carried out on boilers
   - 4.3 describe routine maintenance activities for boiler plant operation
   - 4.4 describe the use of standard operating procedures (SOPs)
   - 4.5 describe the need for boiler operating and maintenance logs and the type of information that should be recorded
5. **describe generic shutdown and lay-up procedures for different boiler types**
   - 5.1 describe hot-water boiler shutdown procedures
   - 5.2 describe hot-water boiler extended period lay-up requirements

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5.3 describe steam boiler shutdown and lockout procedures
5.4 describe extended period lay-up requirements for steam boilers

6. describe the points and readings that need to be monitored and recorded in a plant

6.1 discuss recording requirements for operating and performance conditions
6.2 discuss the various systems required to conduct equipment repairs and to manage the related maintenance records
6.3 describe the operational causes, consequences and prevention of water hammer
6.4 describe the consequences and actions required for common equipment failures
6.5 describe the consequences and actions required in the event of boiler accidents

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3037: ENERGY PLANT MAINTENANCE

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the use of hand tools and hoisting and rigging equipment, as well as boiler equipment service, maintenance and cleaning methods.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the safe use of common hand tools in the powerhouse**
   - 1.1 describe the types and proper use of equipment, including hacksaws, files, chisels, hammers, screwdrivers and wrenches
   - 1.2 describe the types and proper use of hand threading tools
   - 1.3 describe the types and proper use of measuring tools
   - 1.4 describe the proper layout of work and the use of layout tools
   - 1.5 describe the types and proper use of portable and fixed grinders, hand drills and drill presses and the care of drill bits
2. **describe the safe and proper setup of equipment for hoisting and working above ground**
   - 2.1 describe the requirements for setting up work platforms, in general, and ladders and scaffolding, in particular
   - 2.2 describe the general safety precautions and calculations used when rigging equipment
   - 2.3 describe the general safety precautions used when hoisting equipment
   - 2.4 discuss the correct use and limitations of wire cable and rope, including cable attachments and rope knots
   - 2.5 list and describe common types of metal fasteners, such as screws, bolts, studs, nuts and washers
3. **describe the service and maintenance required for boilers**
   - 3.1 describe the general maintenance and servicing requirements for packaged fire-tube and cast iron sectional boilers
   - 3.2 identify the operational procedures for wet and dry boiler lay-ups
   - 3.3 describe ways of detecting fire tube and tubesheet leaks
   - 3.4 describe the general procedure for the removal and replacement of defective fire tubes
4. **discuss the procedure for preparing a boiler for inspection and cleaning and describe mechanical and chemical boiler cleaning methods**
   - 4.1 list the steps and precautions needed to prepare a boiler for inspection
   - 4.2 describe the internal inspection of a boiler
   - 4.3 describe the methods and tools used to mechanically clean boilers
   - 4.4 describe two methods used to chemically clean boilers

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5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:

- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:

- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:

- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals

6.2 identify steps to achieve goals

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COURSE PEN3038: IN-PLANT WATER TREATMENT

Level: Advanced

Prerequisite: None

Description: Students will be able to describe water treatment principles, methods and equipment used in an energy plant.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the general principles, methods and equipment used in preparing raw feedwater for steam production**
   - 1.1 describe typical impurities and their effects on plant and boiler water pre-treatment systems and their treatment process
   - 1.2 describe the equipment requirements for pre-treatment of energy plant water systems
   - 1.3 describe water filtration and the removal of suspended solids
   - 1.4 describe the purpose, processes and equipment used in water softening
   - 1.5 describe the theory, processes and equipment used in deaeration
2. **describe the general principles, methods and equipment used for internal boiler water treatment**
   - 2.1 describe the types of problems and associated treatments related to internal boiler water contamination
   - 2.2 describe internal boiler feedwater chemical-feed systems
   - 2.3 describe standard boiler water tests, measurement and treatment
3. **discuss the general principles, methods and equipment used for the treatment of condensate**
   - 3.1 describe condensate treatment and the effects of non-treatment
   - 3.2 describe the tests conducted on condensate
4. **discuss the general principles, methods and equipment used for the treatment of condenser water and their effects on the cooling tower**
   - 4.1 describe the effects of water on condensers and cooling-tower materials
   - 4.2 describe condenser water systems and water treatment
   - 4.3 describe cooling-tower and condenser water tests addressing common treatments
5. **describe recirculating-water systems and their effects, treatment and tests**
   - 5.1 describe recirculating-water system corrosion and deposition
   - 5.2 describe the use of sacrificial anodes and measurement techniques to determine corrosion
   - 5.3 describe glycol-system testing requirements
   - 5.4 discuss the monitoring tools, procedures and tests used in recirculating-water systems
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate
     - 6.1.2 manage information

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6.1.3 use numbers
6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
6.2.1 demonstrate positive attitudes and behaviours
6.2.2 be responsible
6.2.3 be adaptable
6.2.4 learn continuously
6.2.5 work safely

6.3 demonstrate teamwork skills to:
6.3.1 work with others
6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3039: PRIME MOVERS AND HEAT ENGINES

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the conversion of heat energy into mechanical energy and the use and operation of steam and gas turbines, condensers and cooling towers and combustion engines in an energy plant.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **discuss the historical conversion of heat energy into mechanical energy**
   - 1.1 differentiate between the terms heat engine and prime mover
   - 1.2 discuss the history of the steam engine and the expansive power of steam
2. **describe the construction and operation of steam turbines**
   - 2.1 describe the principle of operation and major components of a steam turbine
   - 2.2 describe the lubrication and sealing requirements for steam turbine shafts
   - 2.3 describe how the rotational speed of a steam turbine is governed and controlled
   - 2.4 list the steps to follow in a typical steam turbine start-up and shutdown
3. **describe the operation and maintenance of condensers and cooling towers**
   - 3.1 explain the construction and operation of condensers and how they relate to the operation of cooling towers
   - 3.2 explain the principle of operation, the purpose and the major components of cooling towers
   - 3.3 describe the construction and operation of natural draft cooling towers
   - 3.4 describe the construction and operation of mechanical draft cooling towers
   - 3.5 discuss cold-climate operation for cooling towers
   - 3.6 explain typical problems and resolutions required within the operation of cooling towers
4. **describe the application, start-up, operation and maintenance required for gas turbines**
   - 4.1 describe the principle of construction and operation of gas turbines
   - 4.2 identify the operational characteristics of gas turbines
   - 4.3 describe regeneration and combined steam-gas turbine operating cycles
   - 4.4 describe the key elements of gas turbine start-up, operation and auxiliaries
5. **describe the application, construction and operation of internal combustion engines**
   - 5.1 discuss the fuels used in internal combustion engines
   - 5.2 describe the working cycles of the four-stroke and two-stroke spark ignition engines
   - 5.3 describe the working cycle of the four-stroke compression ignition (i.e., diesel) cycle
   - 5.4 describe the construction of basic spark and compression cycle engines
   - 5.5 explain the basic operating considerations for diesel engines
6. **demonstrate basic competencies**
   - 6.1 demonstrate fundamental skills to:
     - 6.1.1 communicate

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6.1.2 manage information
6.1.3 use numbers
6.1.4 think and solve problems

6.2 demonstrate personal management skills to:
6.2.1 demonstrate positive attitudes and behaviours
6.2.2 be responsible
6.2.3 be adaptable
6.2.4 learn continuously
6.2.5 work safely

6.3 demonstrate teamwork skills to:
6.3.1 work with others
6.3.2 participate in projects and tasks

7. create a transitional strategy to accommodate personal changes and build personal values

7.1 identify short-term and long-term goals
7.2 identify steps to achieve goals

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COURSE PEN3040: AUXILIARY BUILDING SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe various lighting systems, water supply systems and drainage systems used in energy facilities.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the various lighting systems and some of the basic design considerations for lighting a space**
   - 1.1 describe the common types of lighting equipment and systems
   - 1.2 discuss the different types of artificial light sources
   - 1.3 explain the various methods of lighting control
   - 1.4 describe the general requirements and criteria for emergency lighting in buildings
   - 1.5 discuss the interrelationship between lighting, air conditioning and energy conservation in buildings
2. **explain the various water supply systems used in buildings and plants**
   - 2.1 describe the cold-water distribution system in buildings and plants
   - 2.2 describe the hot-water distribution system in buildings and plants
   - 2.3 describe the construction and operation of building system hot-water heaters, including temperature regulation
   - 2.4 describe the construction and operation of water system protective devices in buildings
   - 2.5 explain what is meant by backflow prevention and describe the common methods used
   - 2.6 describe the maintenance requirements for the components in a building water distribution system
3. **describe the design and components of various drainage systems used in facilities**
   - 3.1 describe the overall layout of building drainage systems
   - 3.2 describe stormwater drainage systems for buildings
   - 3.3 describe how surface runoff is managed to minimize environmental impact
4. **demonstrate basic competencies**
   - 4.1 demonstrate fundamental skills to:
     - 4.1.1 communicate
     - 4.1.2 manage information
     - 4.1.3 use numbers
     - 4.1.4 think and solve problems
   - 4.2 demonstrate personal management skills to:
     - 4.2.1 demonstrate positive attitudes and behaviours
     - 4.2.2 be responsible
     - 4.2.3 be adaptable
     - 4.2.4 learn continuously

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4.2.5 work safely

4.3 demonstrate teamwork skills to:

4.3.1 work with others

4.3.2 participate in projects and tasks

5. create a transitional strategy to accommodate personal changes and build personal values

5.1 identify short-term and long-term goals

5.2 identify steps to achieve goals

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COURSE PEN3041: REFRIGERATION

Level: Advanced

Prerequisite: None

Description: Students will be able to explain refrigeration, the properties of refrigerants and the operation and the maintenance of compression and absorption refrigeration systems.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the basic concept of refrigeration and refrigerants**
   - 1.1 explain the fundamentals of refrigeration
   - 1.2 describe the cycle of operations in a vapour-compression refrigeration system
   - 1.3 explain how operating temperatures and pressures are selected and related for a vapour-compression refrigeration system
   - 1.4 state how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance
   - 1.5 describe how refrigerants are classified
   - 1.6 describe the thermodynamic properties of refrigerants
   - 1.7 describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity and flammability
   - 1.8 describe the safety concerns of common refrigerants, such as R 717, CFCs and HCFCs
2. **describe the operating principles of compression refrigeration systems**
   - 2.1 describe the basic layout of compression refrigeration systems
   - 2.2 distinguish between direct and indirect refrigeration systems
   - 2.3 describe the layout of packaged refrigeration systems and the role of a refrigeration economizer
   - 2.4 describe the special types of refrigeration compressors and how regular compressors are adapted for refrigeration use
   - 2.5 describe the special designs of refrigeration system evaporators and condensers
   - 2.6 discuss refrigeration condenser operation and maintenance requirements
3. **describe the purposes and operating principles of refrigeration system operational and safety controls**
   - 3.1 describe the special application of controls in a refrigeration system
   - 3.2 list the safety shutdown devices specific to centrifugal compressor water chillers
   - 3.3 describe typical refrigeration system safety shutdown devices
   - 3.4 describe the construction and operation of compression refrigeration cycle expansion valves
   - 3.5 describe the different methods used to control the capacity of evaporators
   - 3.6 describe the different methods used to control the capacity of refrigeration compressors
   - 3.7 discuss refrigeration auxiliaries
   - 3.8 identify procedures for refrigeration system leak tests

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3.9 describe how a refrigeration system is dried and charged prior to start-up
3.10 list the steps for adding oil to an in-service refrigeration compressor
3.11 describe the start-up and shutdown procedures for a compression refrigeration system
3.12 describe operational log sheets and preventative maintenance procedures for refrigeration systems
3.13 describe how a refrigeration system is purged of non-condensable gases
3.14 describe condenser operation and maintenance
3.15 explain typical problems and resolution related to refrigeration systems

4. describe the operating principle, maintenance and operation of absorption refrigeration systems

4.1 describe the basic absorption system, comparing differences to the compression system
4.2 describe the theory and operation of an ammonia absorption refrigeration system
4.3 describe the theory and operation of a lithium bromide absorption refrigeration system
4.4 explain the operation of absorption refrigeration systems with respect to crystallization and dilution
4.5 describe the major parts/systems of an absorption system, including heat exchanger bypass system, pump motor cooling and lubrication and purging system
4.6 describe the start-up and shutdown procedures for an absorption refrigeration system
4.7 describe the preventive maintenance that should be performed on an absorption refrigeration system
4.8 explain typical problems and resolutions related to an absorption refrigeration system

5. demonstrate basic competencies

5.1 demonstrate fundamental skills to:
- 5.1.1 communicate
- 5.1.2 manage information
- 5.1.3 use numbers
- 5.1.4 think and solve problems

5.2 demonstrate personal management skills to:
- 5.2.1 demonstrate positive attitudes and behaviours
- 5.2.2 be responsible
- 5.2.3 be adaptable
- 5.2.4 learn continuously
- 5.2.5 work safely

5.3 demonstrate teamwork skills to:
- 5.3.1 work with others
- 5.3.2 participate in projects and tasks

6. create a transitional strategy to accommodate personal changes and build personal values

6.1 identify short-term and long-term goals
6.2 identify steps to achieve goals

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COURSE PEN3042: HEATING, VENTILATING AND AIR CONDITIONING

Level: Advanced

Prerequisite: None

Description: Students will be able to describe methods for air distribution, conditioning and humidification used in buildings and energy plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **explain the methods and techniques for conditioning air for energy plants and buildings**
   - 1.1 discuss the process to condition air for human comfort and health
   - 1.2 list the categories and functions of heating, ventilating and air conditioning (HVAC) systems
   - 1.3 describe the operation of air-handling units
   - 1.4 define the terms humidity, relative humidity and dew point
   - 1.5 define the terms dry-bulb temperature and wet-bulb temperature and describe how they relate to relative humidity
2. **explain the equipment and principles of humidification**
   - 2.1 describe the general purpose and principles of humidification
   - 2.2 describe residential and warm-air types of humidifiers
   - 2.3 describe industrial and commercial types of humidifiers
3. **describe airflow behaviour and the movement of air through distribution systems**
   - 3.1 discuss the theory of airflow and pressure conversions
   - 3.2 describe the major types of air-handling fans and their construction and operation
   - 3.3 interpret fan-performance curves
   - 3.4 describe fan motors, drives and belt guards
   - 3.5 describe fan-volume controls
4. **describe various ventilation systems, including various types of air filters used in these systems**
   - 4.1 explain the difference between natural and mechanical ventilation
   - 4.2 describe the various contaminants found in air
   - 4.3 describe the types of air-cleaning devices used in industrial/commercial buildings
5. **describe the designs and components of duct systems used in HVAC applications**
   - 5.1 explain how systems of air ducts are classified
   - 5.2 describe air-duct materials, system layout, fabrication and installation
   - 5.3 describe air-duct leakage
   - 5.4 identify the types of liners, dampers and louvres used in air-duct systems
   - 5.5 describe terminal air-distribution devices, including the principles of diffusion, induction, entrainment and aspiration

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6. describe the various types and operation of coils used in HVAC systems

6.1 explain how steam, hot-water and glycol coils are sized, configured and operated to reduce the chance of freezing

6.2 describe the installation recommendations for coils, piping, steam traps, control valves, air vents and vacuum-relief devices

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:

- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:

- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:

- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals

8.2 identify steps to achieve goals

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COURSE PEN3043: ENVIRONMENTAL AND CONTROL SYSTEMS

Level: Advanced

Prerequisite: None

Description: Students will be able to describe the operation and maintenance of different types of heating systems used in buildings and energy plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **describe the components, operating principles and maintenance procedures of steam-heating systems**
   - 1.1 describe the construction and operation of steam-heating system devices used to transfer heat from the steam to a heated space
   - 1.2 describe the auxiliary equipment used in a steam-heating system, including air vents, radiator valves and traps and condensate-return equipment
   - 1.3 describe standard types of piping and equipment layout for steam-heating systems
   - 1.4 describe the general operation and maintenance of steam-heating systems
   - 1.5 explain typical problems and resolutions in the operation of steam-heating systems
2. **describe the various designs, equipment and operation of hot-water-heating systems**
   - 2.1 describe the standard piping and circulation layouts of hot-water-heating systems
   - 2.2 compare the advantages and disadvantages of hot-water- and steam-heating systems
   - 2.3 describe various types of special hot-water-heating systems
   - 2.4 describe the purpose and function of standard hot-water-heating system accessories
   - 2.5 explain how the location of the hot-water circulating pump and the expansion tank are determined
   - 2.6 describe the routine operation of hot-water-heating systems, including cleaning, filling and starting and the use of glycol
   - 2.7 explain typical problems and resolutions in the operation of steam-heating systems
3. **describe common heating systems encountered by power engineers**
   - 3.1 describe natural gas fueled warm-air-heating systems
   - 3.2 describe the recommended maintenance procedures for warm-air-heating and ventilating systems
   - 3.3 discuss the concept, application, construction and operation of infrared heaters
   - 3.4 discuss the different methods of electric heating and the advantages and disadvantages of electric-heating systems as compared to other types
4. **describe central, unitary and combined heating, ventilating and air conditioning (HVAC) systems**
   - 4.1 describe general layout and operation of unitary air-conditioning systems
   - 4.2 describe general layout and operation of central air-conditioning systems
   - 4.3 describe general layout and operation of combined air-conditioning systems
   - 4.4 discuss how HVAC systems should be operated under different situations

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5. describe heat gains and heat losses and common methods for energy recovery

5.1 define heat transmission terminology
5.2 describe heat gain and heat loss analysis in a building or energy plant
5.3 describe the general principles of HVAC heat recovery

6. describe the control systems strategies used in HVAC systems

6.1 describe a basic ventilation control strategy for HVAC systems
6.2 describe heating control strategies for HVAC systems
6.3 describe humidification, dehumidification and cooling control strategies for HVAC systems
6.4 describe volume control with static-pressure regulation for HVAC systems

7. demonstrate basic competencies

7.1 demonstrate fundamental skills to:
- 7.1.1 communicate
- 7.1.2 manage information
- 7.1.3 use numbers
- 7.1.4 think and solve problems

7.2 demonstrate personal management skills to:
- 7.2.1 demonstrate positive attitudes and behaviours
- 7.2.2 be responsible
- 7.2.3 be adaptable
- 7.2.4 learn continuously
- 7.2.5 work safely

7.3 demonstrate teamwork skills to:
- 7.3.1 work with others
- 7.3.2 participate in projects and tasks

8. create a transitional strategy to accommodate personal changes and build personal values

8.1 identify short-term and long-term goals
8.2 identify steps to achieve goals

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COURSE PEN3044: INDUSTRIAL PLANT CONFIGURATIONS

Level: Advanced

Prerequisite: None

Description: Students will be able to identify steam-related processes employed by hydrocarbon-centric and common industrial plants.

Parameters: This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **identify steam-related processes employed in hydrocarbon-centric plants**
   - 1.1 identify standard thermal system pathways and segments commonly used in plants
   - 1.2 identify equipment and processes in heat transfer fluid (HTF) heating systems
   - 1.3 identify the main thermal processes used in oil-refining industries
   - 1.4 describe the main processes used in steam-assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS)
   - 1.5 identify thermal processes used in gas separation and compression plants
2. **identify steam-related processes employed in common industrial plants**
   - 2.1 identify the main steam/boiler processes used in wood and biomass processing plants
   - 2.2 identify the important thermal processes used in food production and preservation
   - 2.3 identify the common processes and equipment used in metallurgical processing plants
3. **demonstrate basic competencies**
   - 3.1 demonstrate fundamental skills to:
     - 3.1.1 communicate
     - 3.1.2 manage information
     - 3.1.3 use numbers
     - 3.1.4 think and solve problems
   - 3.2 demonstrate personal management skills to:
     - 3.2.1 demonstrate positive attitudes and behaviours
     - 3.2.2 be responsible
     - 3.2.3 be adaptable
     - 3.2.4 learn continuously
     - 3.2.5 work safely
   - 3.3 demonstrate teamwork skills to:
     - 3.3.1 work with others
     - 3.3.2 participate in projects and tasks
4. **create a transitional strategy to accommodate personal changes and build personal values**
   - 4.1 identify short-term and long-term goals
   - 4.2 identify steps to achieve goals

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COURSE PEN3605: PEN PRACTICUM 4A

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3610: PEN PRACTICUM 4B

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3615: PEN PRACTICUM 4C

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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COURSE PEN3620: PEN PRACTICUM 4D

Level: Advanced

Prerequisite: None

Description: Students, on the work site, continue to develop and refine those competencies developed in related Career and Technology Studies (CTS) occupational areas, previous practicums and other experiences.

Parameters: This course is for students continuing to work toward attaining a recognized 4th class power engineer credential offered by an agency external to the school.

This course can only be offered through a formal partnership agreement with an eligible post-secondary institution (PSI) recognized by Alberta Education. Access a list of eligible PSIs on the Dual Credit Pathways web page on Alberta Education's website. The PSI must also be approved by the Alberta Boilers Safety Association (ABSA). Access ASBA's accepted power engineer program list under "Certification and Exams" on the ABSA website.

Outcomes: The student will:

1. **perform assigned tasks and responsibilities efficiently and effectively, as required by the agency granting credentials**
   - 1.1 identify regulations and regulatory bodies related to the credential
   - 1.2 describe personal roles and responsibilities, including:
     - 1.2.1 key responsibilities
     - 1.2.2 support functions/responsibilities
     - 1.2.3 code of ethics
   - 1.3 describe personal work responsibilities and categorize them as:
     - 1.3.1 routine tasks; e.g., daily, weekly, monthly, yearly
     - 1.3.2 non-routine tasks; e.g., emergencies
     - 1.3.3 tasks requiring personal judgement
     - 1.3.4 tasks requiring approval of a supervisor
2. **analyze personal performance in relation to established standards**
   - 2.1 evaluate application of competencies developed in related CTS courses
   - 2.2 evaluate standards of performance in terms of:
     - 2.2.1 quality of work
     - 2.2.2 quantity of work
   - 2.3 evaluate adherence to workplace policies and procedures related to health and safety
   - 2.4 evaluate the work environment in terms of:
     - 2.4.1 location
     - 2.4.2 floor plan of work area
     - 2.4.3 analysis of workflow patterns
   - 2.5 evaluate a professional in a related occupation in terms of:
     - 2.5.1 training and certification
     - 2.5.2 interpersonal skills
     - 2.5.3 technical skills
     - 2.5.4 professional ethics

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3. demonstrate basic competencies

- 3.1 demonstrate fundamental skills to:
  - 3.1.1 communicate
  - 3.1.2 manage information
  - 3.1.3 use numbers
  - 3.1.4 think and solve problems
- 3.2 demonstrate personal management skills to:
  - 3.2.1 demonstrate positive attitudes and behaviours
  - 3.2.2 be responsible
  - 3.2.3 be adaptable
  - 3.2.4 learn continuously
  - 3.2.5 work safely
- 3.3 demonstrate teamwork skills to:
  - 3.3.1 work with others
  - 3.3.2 participate in projects and tasks

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