



**4th Class Curriculum
Document
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By BFB**

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The "Curriculum Statement (Objective)" Column contains the IPECC Curriculum Statement, and may contain additional PanGlobal objectives, if there are any for the topic.

The Learning Material Reference Column currently refers to the PanGlobal materials unless otherwise stated. This document is divided by exam papers. The numbers in the Learning Materials Reference column refer to the "Part" (A or B), chapter number in the materials and the Objective number.

Please see the end of the document for suggested pre study materials.

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
A1	Elementary Mechanics and Dynamics	Elementary Mechanics and Dynamics
A1.1	Perform basic calculations and define basic terms used in the study of mechanics	Introduction to Basic Mechanics Apply basic terms and calculations used in the study of Mechanics
		Define mass, force, acceleration, velocity, and weight
		Perform simple calculations involving force, pressure, work, power and energy
A1.2	Perform calculations using forces and moments, and determine whether or not a system is in equilibrium	Forces & Moments Perform calculations involving forces and moments, and determine if a system of forces is in equilibrium
		Define the " moment" of a force and its units
		Determine the direction and calculate the magnitude of the moment of a force
A1.3	Define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency.	Simple Machines Perform calculations relating to mechanical advantage, velocity ratio and efficiency
		Define the term simple machine and apply to calculations of mechanical advantage, velocity ratio and efficiency of simple machines
A1.4	Define and identify scalar and vector quantities and solve simple vector problems graphically	Scalars & Vectors Define and identify scalar and vector quantities and solve simple vector problems graphically
		Define scalar and vector quantities as they apply to drawing vector diagrams
A1.5	Define speed, velocity, distance, displacement, and acceleration and solve simple linear problems involving these terms	Linear Velocity & Acceleration Solve simple problems involving linear velocity, time, and distance
		Solve distance, displacement, speed, and velocity problems
		Draw graphs of velocity as a function of time
		Define acceleration state its units, and solve simple acceleration problems
		Apply mathematical formulae relating acceleration, velocity, distance and time to solve problems
A1.6	Define force, work, pressure, power and,	Force, Work, Pressure, Power & Energy

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	energy and perform calculations involving the relationships between these mechanical terms	Perform calculations involving force, work, pressure, power, and energy
		Perform calculations involving force and work
		Perform calculations involving gauge, atmospheric, and absolute pressure
		Perform calculations involving power and different forms of mechanical energy
A1.7	Describe friction and solve problems involving friction on a horizontal plane	Friction Solve problems involving friction
		Apply the laws governing the types of friction
		Apply the coefficient of friction to problems involving forces on a horizontal plane
A1.8	Explain: a. The physical properties of materials and how these properties affect the materials behaviour when external forces are applied b. Stress and the deformation of bodies caused by externally applied forces, and the internal forces that resist these deformations, including tensile, compressive, shear stresses plus factor of safety	Stress & Strain Explain physical properties of materials and how their behaviour is affected when external forces are applied
		Describe the characteristics of materials, including elasticity, stiffness, plasticity, ductility, toughness, brittleness, and hardness
		Calculate stress including tensile, compressive, and shear stresses within rigid body members due to external loads
		Calculate the strain of members under load
A1.9	Explain the common examples of power transmission systems, including speed changes, transmitted power and efficiency	Power Transmission Perform calculations pertaining to common power transmission systems
		Calculate pulley speeds, transmitted power, and efficiency of belt drive systems
		Calculate gear speeds for gear and chain drive systems
A2	Elementary Chemistry and Thermodynamics	Elementary Physical, Chemical and Thermodynamic Principles
A2.10	Explain basic chemistry principles, basic types of matter and their properties	Introduction to Matter & Chemistry Identify basic types of matter, their properties and the associated chemical principles
		Differentiate among the physical states of matter
		Differentiate between chemical and physical changes in matter
		Classify matter as either a type of mixture or a pure substance
		Describe the purpose and uses of the periodic table using the parts of an atom
		Describe the three main ways atoms bond together: covalent, ionic, and metallic bonding
		Discuss chemical equations and their purpose
		Perform simple stoichiometric calculations
		Demonstrate how unstable compounds are combined to make stable compounds
A2.11	Explain the principles of thermodynamics, including the laws of thermodynamics	Introduction to Thermodynamics Explain the principles and laws of thermodynamics
		Define the first two laws of Thermodynamics
		Define heat and specific heat, and perform sensible heat calculations
		Describe the expansion of solids and liquids
A2.12	Explain the modes of heat transfer and theory of operation of heat exchangers	Introduction to Heat Transfer & Heat Exchangers Explain the modes of heat transfer and the theory of heat exchanger operation
		Describe the three modes of heat transfer with reference to heat exchangers
		Discuss the general design and construction of typical heat exchangers
		Describe heat transfer fluids and how they affect the

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		operation of a heat exchanger, including fouling, leakage and vapour locking.
		Describe heat exchanger inspection, maintenance, and operation, including placing them in service and removing them from service
A2.13	Describe the principles of the thermodynamics of steam and the associated terms	Thermodynamics of Steam Apply the thermodynamic principles through practical applications using the steam tables and the temperature-enthalpy chart
		Describe heat as it relates to steam, water, and ice
		Explain the various columns of the steam tables
		Explain the thermodynamic principles of steam, using the steam tables
A3	Jurisdictional Legislation, Codes and Standards for Power Engineers	Introduction to Power Engineering and its Governance in Canada
		Introduction to Power Engineering Describe the Power Engineer profession
		Describe Steam, its uses and the basic steam cycle
		Describe the role and duties of a Power Engineer
		Describe how shift work affects sleep patterns, diet, and overall health
A3.14	Describe the purpose of Jurisdictional acts and regulations with respect to boilers and pressure vessels for Power Engineers.	Jurisdictional Legislation for Power Engineers Describe the application of Jurisdictional Acts and Regulations with respect to Power Engineers, boilers and pressure vessels
		Describe how the Power Engineering profession is regulated in Canada
		Explain the purpose and scope of your Jurisdictional Act and Regulations pertaining to Power Engineering and Pressure Equipment.
		Explain the purpose and intent of the Regulations governing Power Engineers and Pressure Welders.
A3.15	Describe the purpose of Codes and Standards with respect to boilers and pressure vessels and piping for Power Engineers.	Codes & Standards for Power Engineers & Pressure Vessels Describe the purpose of boiler and pressure vessel Codes and Standards
		Discuss the history of how codes and standards became necessary in the pressure equipment field
		Explain the Content and use of the CSA-B51 Boiler, Pressure Vessel, and Pressure Piping code
		Explain the Content and use of the CSA-B52 Mechanical Refrigeration Code
		Explain the Content and use of ASME Boiler and Pressure Vessel Code (ASME BPVC) Section 1 Power Boilers
		Explain the Content and use of ASME BPVC Section VII--Recommended Guidelines for the Care of Power Boilers
		Explain the Content and use of ASME BPVC Section IV--Rules for Construction of Heating Boilers
		Explain the Content and use of ASME BPVC Section VI--Recommended Rules for the Care and Operation of Heating Boilers
		Explain the purpose, intent, and limitation of ASME CSD-1 (Controls and Safety Devices) Standard
A4	Power Plant / Heating Plant Safety	Introduction to Plant and Fire Safety
A4.16	Describe general plant safety in Power, Heating, Pressure and Industrial plants that employ Power Engineers	Introduction to Plant Safety Describe general plant safety as it relates to Power Engineers
		Discuss the cost and effects of workplace accidents
		Describe the basic hazards that may be in an energy plant, and the basic Personal Protective Equipment that may be required
		Define, give examples of, and describe common powerhouse hazards
		Describe Industrial health and safety management system(s)
		Describe Hazard Assessment and Control programs
A4.17	Describe the common safety programs that	Plant Safety Programs

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	are generally applied in plants	Describe common safety programs generally applied in plants
		Describe common occupational health and safety (OH&S) programs found in most plants
		Describe industrial safety training programs in which Power Engineers may require additional training
		Discuss safe work permits
		Describe methods of equipment isolation and lock out
A4.18	Describe the procedures for safe storage and handling of dangerous materials	Handling of Dangerous Materials Describe the policies and procedures for safe storage and handling of dangerous materials
		Discuss the WHMIS system
		Discuss the essential components required in the WHMIS systems
		Describe the safe handling and use of gas cylinders in an energy plant (Power Plant)
		Discuss the safe handling of Hydrocarbons
A4.19	Explain fire safety in a plant	Plant Fire Safety Explain fire safety in an industrial plant
		Discuss the theory, terminology, and the life safety issues associated with fires
		Explain the five classes of fires and describe the types of fire extinguishing media and how they act on these fires
		Explain fire prevention
		Discuss fire prevention methods for the five classes of fires
A4.20	Describe the causes of, extinguishing methods and preventive measures for fires	Fire Extinguishing Methods & Equipment Describe typical fire extinguishing equipment and its operation in plant environments
		Describe the construction and operation of various types of portable fire extinguishers
		Discuss the inspection and maintenance requirements for portable fire extinguishers
		Describe the types, layout, and operation of standpipe and sprinkler systems
		Discuss the maintenance requirements of standpipe and sprinkler system components
		Describe the purpose, operation, and maintenance of fire pumps
A5	Environment	Introduction to Plant Operations and the Environment
A5.21	Explain how the environment is related to the operating plant.	Introduction to the Environment Identify environmental considerations and how they relate to an operating plant
		Describe four important Biogeochemical Cycles that operate within the environment
		Describe typical interdependencies seen among elements within an "ecosystem."
		List the types of impacts that operating facilities can have on the environment
		Describe the alert processes related to environmental problems of plants
		Explain the importance of "attitude" in limiting environmental impacts of plants
		Describe the long term environmental impacts after the decommissioning and abandonment of plants
A5.22	Explain how gas and noise emissions affect plant operation	Gas & Noise Emissions Explain how gas and noise emissions affect plant operations
		Identify the sources and effects of common gases and vapours that have an adverse environmental impact
		Identify the common greenhouse and acid rain causing gases and describe their effects
		Describe the common methods for monitoring and reducing gaseous pollutants
		Describe the effects of noise pollution and methods of identifying, measuring, and controlling it
A5.23	Explain how liquid and solid emissions affect plant operation	Liquid & Solid Emissions Explain how liquid and solid emissions affect plant operation

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		Describe the sources and effects of solid pollutants from energy plants
		Describe the theory of operation of separators/collectors and monitoring of flue gas particulates
		Describe the disposal methods of solid waste from energy plants
		List sources and effects of liquid waste and thermal pollution
		Describe the preventive measures that can be taken to prevent liquid and thermal pollution
		Describe methods of liquid waste disposal
A6	Material and Welding	Elements of Material Science and Welding Technology
A6.24	Describe the mechanical properties of engineering materials and the ability of alloying elements to change the mechanical properties of materials, and identify nonferrous materials as used in engineering	Energy Plant Construction & Operation Materials Describe the mechanical properties of engineering used in engineering
		Describe the mechanical properties of materials
		Describe the various types of ferrous materials
		Describe the various types of non-ferrous materials
A6.25	Describe the welding processes that are relevant to the plant and Power Engineer	Introduction to Welding Describe welding processes relevant to the plant and Power Engineering
		Describe non-fusion welding process, equipment used, and methods
		Describe forge and oxy-fuel fusion welding processes and cutting processes
		Describe metal arc welding processes
		Describe heat treatment of welds
		Describe the types of weld joints used in pressure vessel construction
		Describe the additional construction components required for pressure vessels to ensure structural integrity and "access"
A6.26	Describe the inspection and testing methods of welds and materials used in plants	Boiler and Pressure Vessel Weld Inspection Describe inspection processes and testing methods for welds and materials
		Describe common weld defects.
		Describe the process of Visual Testing of welds
		Describe the process of Penetrant Testing for detecting weld or material defects
		Describe the process of radiographic weld testing
		Describe the process of ultrasonic weld testing
A7	Piping and Valves	Introductory Fluid Handling Technology
A7.27	Describe the basic types of piping, piping connections, supports and drainage devices used in the industry	Introduction to Energy Plant Piping Systems Discuss the basic types of piping, piping connections, supports and drainage devices used in industry
		State the applications for the most common materials and identify the sizes of commercial pipe
		Describe methods of connection for screwed, flanged and welded pipe; identify fittings and their markings
		Describe methods and devices used to allow for pipe expansion and support
		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
		Explain the requirements, materials and methods for insulating pipe
A7.28	Describe the design and uses of the valves designs most commonly used in industry plants and on boilers	Introduction to Energy Plant Valves Describe the design and uses of the valve designs most commonly used in Industry and on boilers
		Describe standard valve designs
		Describe the design and operation of specialized boiler valves
		Describe a typical steam pressure reducing station, and the design and operation of steam system pressure-reducing valves
		Discuss valve details, including materials of construction and identification markings

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		Describe typical valve maintenance requirements
A8	Electricity	Basic Concepts in Electrotechnology
A8.29	Describe the concepts of basic electricity and perform simple AC & DC calculations using voltage, current, resistance and power	Introduction to Basic Electricity Apply the concepts of basic electricity while performing simple calculations using voltage, current, resistance, and power
		Describe the atomic structure of matter and its relationship to electricity
		Describe basic electrical circuits
		State Ohm's Law and apply it to single resistor circuits
		Apply Ohm's Law to series resistance circuits
		Apply Ohm's Law to parallel resistance circuits
		Explain Electrical conductors and insulators using examples
		Explain the factors that affect resistance mathematically
		Calculate the power developed in an electrical circuit
A8.30	Describe the basic principles of magnetism as it relates to electricity.	Magnetism & Electromagnetism Describe the basic principles of magnetism
		Describe magnetism and the relationship between magnetism and electricity
		Describe the relationship between electricity and magnetism in an electrical generator
		Describe the relationship between electricity and magnetism in an electric motor
A8.31	Describe the designs and uses of electrical metering devices.	Electrical Metering Devices Describe the design and application of electrical metering devices
		Describe electrical meters and their uses
		Describe how voltage, current, and resistance are measured in an electric circuit
		Describe the construction and operation of a kilowatt hour meter
A8.32	Describe the operating principles of the various types of AC and DC motors and generators.	Motors & Generators Describe the operating principles of the various types of AC and DC motors and generators
		Describe the construction and operation of DC generators and motors
		Describe the construction and operation of AC generators (alternators) and motors
		Interpret the information on a motor nameplate
		Perform basic calculations relating to power factor and power factor correction
A8.33	Describe the operating principles of electrical transformers.	Transformers Describe the operating principles of electrical transformers
		Describe the principle of operation of transformers
		Perform basic transformer calculations as they relate to the construction and operation of single phase transformers
		Describe the construction and operation of three-phase transformers
		Discuss special transformer types and their applications
		Discuss transformer cooling, safety, and Maintenance
A8.34	Describe an electrical distribution system and safe operation	Electrical Distribution Systems Describe an electrical distribution system
		List and describe the standard types of electrical voltage systems
		Interpret electrical single line diagrams and circuit symbols
		Describe the major components of an electrical distribution system
		Describe the function and operation of fuses and circuit breakers
		Describe the function and operation of alternate power supply system equipment
A9	Energy Plant Instrumentation and Controls	Energy Plant Instrumentation & Controls
A9.35	Describe the overall purpose and function of plant instrumentation and	Introduction to Energy Plant Controls & Instrumentation

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	control systems	Describe the overall purpose and function of plant instrumentation systems
		Describe the concept and basic components of a control loop
		Describe the various means by which control signals are transmitted and the function of transducers
		List and describe the types of instruments that are not control loop components
A9.36	Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition	Introduction to Process Measurement Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition
		Describe the types of pressure sensing and measuring devices
		Describe the types of level sensing and measuring devices
		Describe the types of flow sensing and measuring devices
		Describe the types of temperature sensing and measuring devices
		Describe the types of humidity sensing and measuring devices
		Describe the types of gas (composition) sensing and measuring devices
A9.37	Describe the basic types and functions of transmitters, recorders, controllers, and control actuators	Basic Control & Instrumentation Components Describe the basic types and functions of transmitters, recorders, controllers, and control actuators
		Describe the construction and operational principles of instrumentation transmitters
		Describe the construction and operational principles of instrumentation indicators and recorders
		Describe the construction and operational principles of instrumentation controllers
		Describe the construction and operational principles of final control elements
A9.38	Describe the operation of programming controls for boilers and discuss testing and maintenance procedures for these controls	Introduction to Programmable Controllers Describe the operation of programming controls for boilers including applicable testing and maintenance procedures
		Discuss how programmable controllers work and how they act as sequencers for equipment
		Describe applications of programmable controllers
		Explain the HMI (human machine interface) and purpose of touchscreen displays, functions, and alarm handling
A9.39	Describe the design and operation of electronic control systems	Electronic Control Systems and Computer Applications Describe the design and operation of electronic control systems
		Discuss electronic process control systems
		Describe computers and how they operate within control systems
		Describe the applications of computerized control systems and plant computers
A9.40	Describe the design and operation of electrical control systems	Electrical Control Systems Describe the design and operation of electrical control systems
		Describe the basic construction and operation of various electric control system components
		Describe the function of control devices in electric control systems
		Explain the operating sequence of basic electric control circuits
A10	Plant Communication	Fundamental Industrial Communication Skills
A10.41	Describe how to setup plant and equipment sketches, and how to complete a plant line tracing diagram	Energy Plant Sketching Create engineering equipment sketches
		Create sketches using centre lines and dimensioning
		Recognize standard views of an object
		Recognize cross hatching methods in sectional drawings
		Identify common drawing symbols and lines used in plant

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		system trace drawings
		Complete a plant trace drawing
A10.42	Describe the common types of diagrams used in plants	Plant Diagrams & Drawings Identify common types of diagrams used in plants
		Explain the layout of plant diagrams
		Explain the use of process flow diagrams (PFDs)
		Explain the use of piping and instrumentation diagrams (P&IDs).
		Explain the use of general arrangement, block plans, and equipment diagrams.
A10.43	Describe the different types of and proper use of plant communication systems	Plant Communications Describe the types and proper usage of plant communication systems
		Discuss effective written and verbal communication skills, including the use of two-way radios
		Describe the legal documentation requirements for Power Engineers, including log books and log sheets
		Discuss the elements of Maintenance Management Systems, including work requests and work orders
		Discuss the purpose, revision, and control of Standard Operating Procedures
		Discuss updating procedures for Piping and Instrumentation Diagrams
A11	Boilers	Introduction to Boiler Designs
A11.44	Describe the historical development of boilers, boiler design, components and configuration	Introduction to Boilers Describe the historical development of boilers, boiler design, components and configuration
		Describe the history of boiler applications, design, and modern boiler improvements
		Describe Packaged Boilers
		Describe the construction of field assembled and field erected boilers
		Describe components and design aspects common to all boiler vessels
A11.45	Describe the design, components and characteristics of firetube boilers	Firetube Boilers Describe the design, components, and characteristics of firetube boilers
		Differentiate the Scotch Boiler from the other firetube boilers, and describe its development history
		Describe circulation patterns in firetube boilers
		Discuss construction details of firetube boilers
A11.46	Describe the design, components and characteristics of watertube boilers	Watertube Boilers Describe the design, components and characteristics of watertube boilers
		Describe the design and operating principles of watertube boilers
		Describe watertube boiler components
		Explain the design and application of packaged watertube boilers
		Describe the design, construction, and components of large scale steam generating units
A11.47	Explain the general design and application of electric boilers	Electric Boilers Explain the general design and application of electric boilers
		Discuss the advantages and disadvantages of electric boilers
		Describe the construction and operating principle of electric boilers
A11.48	Describe the special designs of boilers used in heating plants	Special Boiler Designs for Heating Plants Describe the special design considerations of boilers used in heating plants
		Describe the design of watertube and coil tube heating boilers
		Describe cast iron boilers and vertical firetube boilers
		Describe the construction and application of firetube heating boiler designs
A11.49	Describe the differences between ASME section I and ASME section IV boilers	Differences between Power and Heating Boilers Differentiate between ASME section I and ASME section IV

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		boilers
		Discuss the differences between Power Boiler and Heating boiler design and installation
		Discuss the differences between Power Boiler and Heating boiler operation
A12	Boiler Systems	Elements of Boiler Systems
A12.50	Discuss the basic theory of combustion in a boiler, and the equipment used to provide proper combustion conditions	Combustion Discuss the basic theory of combustion and the equipment used to provide proper combustion conditions within a boiler
		Discuss combustion, combustion equations, and the relationship between theoretical and excess air
		Discuss the characteristics of solid, liquid, and gaseous fuels
		Explain fuel and the effects of combustion on refractory materials
A12.51	Describe the common fuel systems found in boiler systems	Fuel Delivery and Firing Systems Describe common fuel systems found in boiler systems
		Describe solid fuel delivery systems
		Describe the main types of solid fuel firing systems
		Describe gaseous fuel delivery systems
		Describe the main types of gaseous fuel firing systems
		Describe liquid fuel delivery systems
		Describe the main types of liquid fuel firing systems
		Describe flue gas analysis and how it relates to boiler efficiency
A12.52	Describe draft and the basic equipment used to supply combustion air to a boiler furnace	Draft Describe basic concepts and equipment used to supply combustion air to boiler furnaces
		Describe the various air streams that deliver combustion air to a furnace
		Relate differential pressure to the creation of draft
		Describe forced, induced, and balanced mechanical draft
		Discuss common methods of controlling combustion air flow
		Discuss common methods of measuring furnace pressures
A12.53	Describe the types of feedwater systems used for boilers	Feedwater Systems Describe Feedwater systems used with boilers
		Describe the overall layout of feedwater, condensate, and make-up water systems
		Describe the valves used in feedwater systems
		Describe the control strategies for single-element, two element, and three element boiler feedwater systems
		Describe methods of supplying feedwater to steam heating boilers.
		Explain the operation of condensate receiver make-up water controls.
		Describe the return of condensate and the supply of feedwater to high-pressure boilers.
A12.54	Describe the purpose, equipment and operation of blow down in boiler systems	Blowoff and Blowdown Systems Describe the purpose, equipment and operation of blowdown in boiler systems
		Describe blowoff, blowoff equipment, and blowoff procedures
		Describe continuous blowdown, blowdown equipment, and blowdown procedures.
		Describe the maintenance and Repair of blowoff systems
A12.55	Describe the purpose, equipment and operation of fireside cleaning in boiler systems	Boiler Fireside Cleaning Systems Describe types of boiler fireside cleaning equipment, their purpose, and their operation
		Describe common options for in-service fireside cleaning
		Describe the construction and operation of retractable sootblowers
		Describe the construction and operation stationary sootblowers
		Describe shot cleaning methods
B1	Lubrication and Bearings	Lubrication and Bearings

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B1.1	Describe the importance of lubrication and the operating principles of lubrication	Lubrication Principles Describe the importance of lubrication and the principles concerned with lubrication
		Discuss the concept of lubrication and list the purposes of a lubricant
		List the various classes and types of lubricants and describe their respective properties and application
		List the properties of lubricating oils, the additives used, and their selection criteria
B1.2	Describe the methods for basic care and maintenance of bearings and their related lubrication systems	Types of Bearings and Lubrication Describe bearing types, methods for care and maintenance of bearings, and bearing lubrication systems
		Define boundary and full fluid film lubrication
		Describe shell (sleeve) bearings
		Describe the construction and operation of antifriction and thrust bearings
		Describe how to clean and replace roller and ball type bearings
		Explain the causes of bearing failure
B2	Pumps and Compressors	Pump and Compressor Types and Operation
B2.3	Describe the construction and operating principles of various types of pumps used in buildings and industrial plants	Types of Pumps Describe the construction and operating principles of various types of pumps used in plants
		List the common pump applications
		Define the terms associated with pump performance
		Describe the common pumps found in plants
B2.4	Describe maintenance procedures for efficient and reliable pump operation.	Pump Operation & Maintenance Describe the major considerations and procedures for pump operation and maintenance
		Discuss the components of a motor and pump assembly
		Describe the types of shaft seals
		Describe standard types of mechanical seals
		Describe pump bearing and shaft alignment equipment and procedures
		Describe centrifugal pump start up and priming procedures
		Describe positive displacement priming, startup and routine
B2.5	Describe the construction and operating principles of the different types of compressors	Introduction to Compressors Describe the operating principles of the different types of compressors
		Describe the main classifications and types of compressors
		Describe gaseous compression systems
B2.6	Describe the startup, operation and shut down of different types of compressors	Compressor Operation & Maintenance Describe the major considerations and general procedures for compressor operation and maintenance
		Describe compressor parts and auxiliary equipment
		Describe the construction and operation of seals for compressors
		Describe the capacity control of compressors
		Describe Preventative Maintenance and routine procedures for compressors
B3	Boiler Safety Devices	Boiler Safety Devices
B3.7	Explain the code and standards requirements, design and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels	Pressure Relief Valves Explain the code requirements, design and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels
		Discuss the code requirements, the construction and operation of ASME Section I pressure relief valves and devices
		Discuss the code requirements, the construction and operation of ASME Section IV pressure relief valves and devices
		Describe the testing and repair of Pressure Relief Valves
		Describe the construction and operation of a temperature (Temperature and Pressure) relief device
B3.8	Explain the design and operation of	Combustion Safety

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	combustion safety controls on burners and boilers	Explain the design and operation of combustion safety controls on burners and boilers
		Describe basic boiler control systems
		Compare the devices/controls that can be either operating or safety circuit
		Describe a Burner Management System (BMS)
		Describe the equipment operation process used to startup and shutdown boilers
		Interpret Burner operating sequence bar graphs and provide a typical sequence of startup and shutdown events
		Describe the construction and operation of burner / boiler flame failure detectors
		Identify testing requirements for burner / boiler flame failure safety devices
B3.9	Describe feedwater control methods and devices used on boilers	Water Level Safety Controls Describe feedwater safety devices and control methods used on boilers
		Describe the construction and operation of boiler low water level fuel cutoff equipment
		List the ASME and CSA code regulations regarding low water fuel cutoff devices
		Describe testing and maintenance of boiler low water level fuel cutoffs
		Describe direct and indirect type water level indicators
B3.10	Describe the code and standards required and operation required fittings, along with the operating principles of fittings found on boilers	Boiler Fittings Relate the code, operation and required fittings to the operating principles of fittings found on boilers
		Explain the code references for boiler fittings
		Describe the code requirements for pressure gauges on steam boilers
		Describe the code requirements for boiler connections and valves on steam boilers
		Describe the code requirements for required fittings on hot water boilers
		Describe types of non-code required fittings used on boilers
		Describe the trim items found on Power and Heating boilers
B3.11	Name and describe the operating and safety controls found on boilers	Operating & Safety Circuits Describe the operating and safety controls found on boilers.
		Discuss various operating controls for steam and hot water boilers
		Describe the safety controls found on boiler and burner systems
		Describe the operation of control and safety devices found on the fuel supplies of boilers
		Describe testing and maintenance requirements for boiler controls
B4	Plant (Boiler) Operations	Boiler Plant Operation and Management
B4.12	Describe the safe and efficient operational procedures that relate to starting up the auxiliary equipment in a boiler plant	Boiler Plant Startup Describe operational procedures related to starting up auxiliary equipment in a boiler plant
		Describe the basic auxiliaries that need to be checked, prepared, or placed in service before starting a boiler plant.
		Describe the general procedures for starting a plant for the first time, or restarting after an outage or turnaround.
		Discuss basic operating practices for starting pumps and fans.
		Describe the general preparation for a hot water boiler startup
		Describe the general preparation for a steam boiler startup
		Describe the safety and housekeeping preparation requirements for boiler plant startup
B4.13	Describe the safe and efficient operational procedures that relate to starting up boiler systems	Boiler Startup Describe procedures for safely starting boiler systems
		Describe operation considerations when warming a cold

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		boiler
		Describe how to start and cut in a hot water boiler
		Describe how to start a single boiler steam plant.
		Describe how to cut in a steam boiler in a multiple boiler plant
		Describe semi-automatic burner ignition systems
		Discuss the post start up inspection for boilers returning to service after major outage.
B4.14	Describe the safe and efficient operational procedures that relate to operating boilers	Boiler Operation Describe operational procedures related to operating boilers
		Describe the operation of a hot water boiler under routine conditions
		Describe routine steam boiler operating duties
		Describe emergency conditions in boiler plants and the required responses
		Describe basic boiler troubleshooting activities
B4.15	Describe the operational checks that need to be conducted for an operating boiler plant	Operational Checks Describe operational checks for operating boiler plants
		Describe the shift-based operator responsibilities for boiler plants
		Describe the safety device operational checks carried out on boilers
		Describe routine maintenance activities for boiler plant operation
		Describe the use of Standard Operating Procedures (SOPs)
		Describe the need for boiler operating and maintenance logs and the type of information that should be recorded
B4.16	Describe generic shutdown and layup procedures for different boilers	Shutdown Procedures Describe generic shutdown and layup procedures for different boiler types
		Describe hot water boiler shutdown procedures
		Describe hot water boiler extended period lay-up requirements
		Describe steam boiler shutdown and lockout procedures
		Describe extended period lay-up requirements for steam boilers
B4.17	Describe the essential points and readings that need to be monitored and recorded in a plant	Boiler Plant Monitoring & Reporting Describe the points and readings that need to be monitored and recorded in a plant
		Discuss recording requirements for operating and performance conditions
		Discuss the various systems required to conduct equipment repairs and to manage the related maintenance records
		Describe the operational causes, consequences, and prevention of Water Hammer
		Describe the consequences and actions required for common equipment failures
		Describe the consequences and actions required in the event of boiler accidents
B5	Power Plant /Heating Plant Maintenance	Energy Plant Maintenance
B5.18	Describe the safe use of common hand tools in the powerhouse	Energy Plant Maintenance I Describe the safe use of common hand tools in the powerhouse
		Describe the types and proper use of equipment including: hacksaws, files, chisels, hammers, screwdrivers and wrenches
		Describe the types and proper use of hand threading tools
		Describe the types and proper use of measuring tools
		Describe the proper layout of work and the use of layout tools
		Describe the types and proper use of portable and fixed grinders, hand drills, drill presses and the care of drill bits
B5.19	Describe mechanical fasteners and the safe and proper setup of equipment for hoisting and working above ground	Energy Plant Maintenance II Describe the safe and proper setup of equipment for hoisting and working above ground
		Describe the requirements for setting up work platforms in general and ladders and scaffolding in particular

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		Describe the general safety precautions and calculations used when rigging equipment
		Describe the general safety precautions used when hoisting equipment
		Discuss the correct use and limitations of wire cable and rope, including cable attachments and rope knots
		List and describe common types of metal fasteners, such as screws, bolts, studs, nuts and washers
B5.20	Describe the service and maintenance required for boilers	Boiler Maintenance Describe the service and maintenance required for boilers
		Describe the general maintenance and servicing requirements for packaged firetube and cast-iron sectional boilers
		Identify the operational procedures for wet and dry boiler lay-ups
		Describe ways of detecting firetube and tubesheet leaks
		Describe the general procedure for the removal and replacement of defective firetubes
B5.21	Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical and chemical boiler cleaning methods	Boiler Cleaning Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical and chemical boiler cleaning methods
		List the steps and precautions to prepare a boiler for inspection
		Describe the internal inspection of a boiler
		Describe the methods and tools used to mechanically clean boilers
		Describe two methods used to chemically clean boilers
B6	Water Treatment	In-Plant Water Treatment
B6.22	Describe the general principles, methods and equipment used in preparing raw feedwater for steam production in a boiler	External Boiler Water Treatment Describe the general principles, methods and equipment used in preparing raw feedwater for steam production
		Describe typical impurities and their effects on plant and boiler water pre-treatment systems, and their treatment process
		Describe the equipment requirements for pre-treatment of plant water systems
		Describe water filtration and the removal of suspended solids
		Describe the purpose, processes, and equipment used in water softening
		Describe the theory, process, and equipment used in deaeration
B6.23	Describe the general principles, methods and equipment used for the internal treatment of boiler water	Internal Boiler Water Treatment Describe the general principles, methods and equipment used for internal boiler water treatment
		Describe the types of problems and associated treatments related to internal boiler water contamination
		Describe internal boiler feedwater chemical feed systems
		Describe standard boiler water tests, measurement, and treatment
B6.24	Discuss the general principles, methods and equipment used for the treatment of condensate	Condensate Treatment Discuss the general principles, methods and equipment used for the treatment of condensate
		Describe condensate treatment and the effects of non-treatment
		Describe the tests conducted on condensate
B6.25	Discuss the general principles, methods and equipment used for the treatment of cooling tower and condenser water	Tower/Condenser Water Treatment Discuss the general principles, methods and equipment used for the treatment of condenser water and their effects on the cooling tower
		Describe the effects of water on condensers and cooling tower materials
		Describe condenser water systems and water treatment
		Describe cooling tower and condenser water tests addressing common treatments
B6.26	Describe cooling water/chilled water effects, treatment and tests	Recirculating System Water Treatment Describe recirculating water systems, their effects,

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		treatment, and tests
		Describe recirculating water system corrosion and deposition
		Describe the use of sacrificial anodes and measurement techniques to determine corrosion
		Describe glycol system testing requirements
		Discuss the monitoring tools, procedures and, tests used in recirculating water systems
B7	Prime Movers and Engines	Types of Prime Movers and Heat Engines
B7.28	Describe the conversion of heat into mechanical energy and the history of the steam engine	Heat Engines and Prime Movers Discuss the historical conversion of heat energy into mechanical energy
		Differentiate between the terms “heat engine” and “prime mover”
		Discuss the history of the steam engine and the expansive power of steam
B7.29	Describe the construction and operation of steam turbines	Steam Turbines Describe the construction and operation of steam turbines
		Describe the principle of operation and major components of a steam turbine
		Describe the lubrication and sealing requirements for steam turbine shafts
		Describe how the rotational speed of a steam turbine is governed and controlled
		List the steps to follow in a typical steam turbine startup and shutdown
B7.30	Describe the operation and maintenance of cooling towers and condensers	Condensers and Cooling Towers Describe the operation and maintenance of condensers and cooling towers
		Explain the construction and operation of condensers and how they relate to the operation of cooling towers
		Explain the principle of operation, the purpose, and the major components of cooling towers
		Describe the construction and operation of natural draft cooling towers
		Describe the construction and operation of mechanical draft cooling towers
		Discuss cold climate operation for cooling towers
		Explain typical problems, and resolutions required within the operation of cooling towers
B7.31	Describe the application, set up, operation and maintenance required for gas turbines	Gas Turbines Describe the application, startup, operation, and maintenance required for gas turbines
		Describe the principle of construction and operation of gas turbines
		Identify the operational characteristics of gas turbines
		Describe regeneration and combined steam-gas turbine operating cycles
		Describe the key elements of gas turbine, start-up operation, and auxiliaries
B7.32	Describe the application, construction, and operation of internal combustion engines	Internal Combustion Engines Describe the application, construction, and operation of internal combustion engines
		Discuss the fuels used in internal combustion engines
		Describe the working cycles of the 4-stroke and 2-stroke spark ignition engines
		Describe the working cycle of the 4-stroke compression ignition (i.e., diesel) cycle
		Describe the construction of basic spark and compression cycle engines
		Explain the basic operating considerations for diesel engines
B8	Auxiliary Building Systems	Plant Auxiliary Systems
B8.33	Explain lighting systems and some of the basic design considerations for lighting a space	Lighting Systems Explain the various lighting systems and some of the basic design considerations for lighting a space
		Describe the common types of lighting equipment and systems

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		Discuss the different types of artificial light sources
		Explain the various methods of lighting control
		Describe the general requirements and criteria for emergency lighting in buildings
		Discuss the interrelationship between lighting, air conditioning, and energy conservation in buildings
B8.34	Explain the various water supply systems used in buildings	Building Water Systems Explain the various water supply systems used in buildings and plants
		Describe the cold water distribution system in buildings and plants
		Describe the hot water distribution system in buildings and plants
		Describe the construction and operation of building system hot water heaters, including temperature regulation
		Describe the construction and operation of water system protective devices in buildings
		Explain what is meant by “backflow prevention” and describe the common methods used
		Describe the maintenance requirements for the components in a building water distribution system
B8.35	Describe the design and components of various sanitary drainage systems used in buildings	Drainage Systems Describe the design and components of various drainage systems used in facilities
		Describe the overall layout of building drainage systems
		Describe storm water drainage systems for buildings
		Describe how surface runoff is managed to minimize environmental impact
B9	Refrigeration	Basic Concepts of Compression and Absorption Refrigeration
B9.36	Explain the basic concept of refrigeration and refrigerants	Refrigeration Basics Explain the basic concept of refrigeration and refrigerants
		Explain the fundamentals of refrigeration
		Describe the cycle of operations in a vapour compression refrigeration system
		Explain how operating temperatures, and pressures are selected and related for a vapour compression refrigeration systems
		State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance
		Describe how refrigerants are classified
		Describe the thermodynamic properties of refrigerants
		Describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity, and flammability
		Describe the safety concerns of common refrigerants, such as R 717, CFC’s and HCFC’s
B9.37	Describe the operating principles, operation and maintenance of compression refrigeration systems	Compression Refrigeration Systems Describe the operating principles of compression refrigeration systems
		Describe the basic layout of compression refrigeration systems
		Distinguish between direct and indirect refrigeration systems
		Describe the layout of packaged refrigeration systems and the role of a refrigeration economizer
		Describe the special types of Refrigeration Compressors, and how regular compressors are adapted for refrigeration use
		Describe the special designs of refrigeration system evaporators and condensers
		Discuss refrigeration condenser operation and maintenance requirements
B9.38	Describe the purposes and operating principles of the operational and safety controls on a refrigeration system	Refrigeration Control and Operation Describe the purposes and operating principles of refrigeration system operational and safety controls
		Describe the special application of controls in a refrigeration

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		system
		List the safety shutdown devices specific to centrifugal compressor water chillers
		Describe typical refrigeration system safety shutdown devices
		Describe the construction and operation of compression refrigeration cycle expansion valves
		Describe the different methods used to control the capacity of evaporators
		Describe the different methods used to control the capacity of refrigeration compressors
		Discuss refrigeration auxiliaries
		Identify refrigeration system leak tests procedures
		Describe how a refrigeration system is dried and charged prior to start-up
		List the steps for adding oil to an in-service refrigeration compressor
		Describe the start-up and shutdown procedure for a compression refrigeration system
		Describe operational log sheets and preventative maintenance procedures for refrigeration systems
		Describe how a refrigeration system is purged of non-condensable gases
		Condenser operation and maintenance (from 38a)
		Explain typical problems and resolution related to refrigeration systems
B9.39	Describe the operating principle, maintenance and operation of absorption refrigeration systems	Absorption Refrigeration Systems Describe the operating principle, maintenance and operation of absorption refrigeration systems
		Describe the basic absorption system, comparing the differences to the compression system
		Describe the theory and operation of an ammonia absorption refrigeration system
		Describe the theory and operation of a lithium bromide absorption refrigeration system
		Explain the operation of absorption refrigeration systems with respect to crystallization and dilution
		Describe the major parts/systems of an absorption system, including: heat exchanger bypass system, pump motor cooling and lubrication, and purging system
		Describe the startup and shutdown procedures for an absorption refrigeration system
		Describe the preventive maintenance that should be performed on an absorption refrigeration system
		Explain typical problems and resolutions related to an absorption refrigeration system
B10	Heating Ventilating and Air Conditioning	HVAC Fundamental for Facility Operators
B10.40	Explain the methods and techniques for conditioning air for human comfort and health	Conditioning the Air Explain the methods and techniques for conditioning air for plants and buildings
		Discuss the process to condition air for human comfort and health
		List the categories and functions of HVAC systems
		Describe the operation of air handling units
		Define the terms humidity, relative humidity and dewpoint
		Define the terms - dry bulb temperature, wet bulb temperature, wet bulb and how they relate to relative humidity
B10.41	Explain the equipment and principles of humidification	Humidification Explain the equipment and principles of humidification
		Describe the general purpose and principles of humidification
		Describe residential and warm air types of humidifiers
		Describe industrial and commercial types of humidifiers
B10.42	Describe the air flow behaviour and movement of air through distribution systems	Fans for Air Distribution Systems Describe the air flow behaviour and movement of air through distribution systems

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		Discuss the theory of air flow and pressure conversions
		Describe the major types of air handling fans, their construction, and operation
		Interpret fan performance curves
		Describe fan motors, drives, and belt guards
		Describe fan volume controls
B10.43	Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems	Ventilation and Air Filters Describe the various ventilation systems including various types of air filters used in these systems
		Explain the difference between natural and mechanical ventilation
		Describe the various contaminants found in air
		Describe the types of air cleaning devices used in industrial/commercial buildings
B10.44	Describe the designs and components of duct systems used in air conditioning	HVAC Duct Systems Describe the designs and components of duct systems used in HVAC applications
		Explain how air duct systems are classified
		Describe air duct materials, system layout, fabrication and installation
		Describe air duct leakage
		Identify the types of liners, dampers, and louvres used in air duct systems
		Describe terminal air distribution devices including the principles of diffusion, induction, entrainment and aspiration
B10.45	Describe the various types of coils used in HVAC systems, and their operation	Types of Coils and Operation Describe the various types and operation of coils used in HVAC systems
		Explain how steam, hot water and Glycol coils are sized, configured and operated to reduce the chance of freezing
		Describe the installation recommendations for coils, piping, steam traps, control valves, air vents, and vacuum relief devices
B11	Heating and Cooling Systems	Building Environmental Systems and Control
B11.46	Describe the operating principles and maintenance procedures of steam heating systems and the components of these systems	Steam Heating Describe the components, operating principles and maintenance procedures of steam heating systems
		Describe the construction and operation of steam heating system devices used to transfer heat from the steam to a heated space
		Describe the auxiliary equipment used in a steam heating system, including air vents, radiator valves and traps, and condensate return equipment
		Describe standard types of piping and equipment layout for steam heating systems
		Describe the general operation and maintenance of steam heating systems
		Explain typical problems, and resolutions in the operation of steam heating systems
B10.47	Describe the various designs of hot water heating systems, as well as their equipment and operation	Hot Water Heating Describe the various designs, equipment, and operation of hot water heating systems
		Describe the standard piping and circulation layouts of hot water heating systems
		Compare the advantages and disadvantages of hot water and steam heating systems
		Describe various types of special hot water heating systems
		Describe the purpose and function of standard hot water heating system accessories
		Explain how the location of the hot water circulating pump and the expansion tank are determined.
		Describe the routine operation of hot water heating systems including cleaning, filling, starting, and use of glycol
		Explain typical problems, and resolutions in the operation of

Syllabus Section#	2017 Syllabus Statement	Curriculum Statement (Objective)
		steam heating systems
B11.48	Describe the common heating systems that a Power Engineer may encounter	Other Heating Systems Describe common heating systems encountered by Power Engineers
		Describe natural gas fueled warm air heating systems
		Describe the recommended maintenance procedures for warm air heating and ventilating systems
		Discuss the concept, application, construction, and operation of infrared heaters
		Discuss the different methods of electric heating, and the advantages and disadvantages of electric heating systems as compared to other types
B11.49	Describe central, Unitary and Combined types of HVAC systems	Cooling Systems and Combination Systems Describe central, Unitary and Combined HVAC systems
		Describe general layout and operation of unitary air conditioning systems
		Describe general layout and operation of central air conditioning systems
		Describe general layout and operation of combined air conditioning systems
		Discuss how HVAC systems should be operated under different situations
B11.50	Describe heat gains and losses and the common methods of recovering energy from the system	Heat Gains and Losses, Heat Recovery Methods Describe heat gains and losses and common methods for energy recovery
		Define heat transmission terminology
		Describe heat gain and heat loss analysis in a building or plant
		Describe the general principles of HVAC heat recovery
B11.51	Describe the control systems strategies used in HVAC systems	HVAC Control Strategy Describe the control systems strategies used in HVAC systems
		Describe a basic ventilation control strategy for HVAC systems
		Describe heating control strategies for HVAC systems
		Describe humidification, dehumidification and cooling control strategies for HVAC systems
		Describe volume control with static pressure regulation for HVAC systems
B12	Types of Plants	Typical Industrial Plant Configurations
B12.52	Identify steam-related processes in some common types of plants that employ Power Engineers	Common Plant Configurations in Hydrocarbon Centric Industries Identify steam-related processes employed in hydrocarbon centric plants
		Identify standard Thermal System pathways and segments commonly used in plants
		Identify Equipment and Processes in Heat Transfer Fluid (HTF) heating systems
		Identify the Main Thermal Processes used in Oil Refining Industries
		Describe the main processes used in Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation (CSS)
		Identify thermal processes used in gas separation and compression plants
B12.53		Other Plant Configurations Identify steam-related processes employed in common types of plants
		Identify the main Steam/Boiler Processes used in Wood and Biomass Processing Plants
		Identify the Important Thermal Processes used in Food Production and Preservation
		Identify the Common Processes and Equipment used in Metallurgical Processing Plants

The following is a suggested pre study set of materials. Basic mathematics is no longer examined by SOPEEC, but is used in many unit with the study materials, without basic math skills the learner will

have problems with the topics applied mechanics, chemistry, thermodynamics, materials, electricity, and boiler combustion.

	Preparatory Math Topics	Applied Mathematics
		SI Units
		Perform simple calculations using SI Units
		Describe basic SI units matching associated symbols for unit prefixes
		Perform unit analyses in simple problems
		List derived SI units and their associated symbols
		Perform conversions between SI and Imperial units
		Basic Arithmetic Operations
		Perform basic arithmetic operations
		Add and subtract integers
		Multiply and divide whole and decimal numbers
		Perform arithmetic operations involving combinations of addition, subtraction, multiplication, division, and powers in the proper order of operation
		Fractions, Decimals & Percentages
		Perform basic arithmetic operations involving fractions, decimals, and percentages
		Identify proper and improper fractions and mixed numbers
		Add, subtract and multiply fractions reducing them to the lowest terms
		Convert fractions to decimal numbers and decimal numbers to fractions
		Analyze percentage problems
		Ratio & Proportion
		Explain the concepts of ratio and proportion
		Convert ratios of one quantity to another quantity
		Solve word problems involving ratios and proportions
		Equations & Transposition
		Identify values for different variables within a formula
		Solve equations and word problems
		Lengths, Lines & Simple Plane Figures
		Relate the measurement of length, types of lines and angles, and the calculation procedures for perimeters and areas of simple plane figures
		Convert measurement units from one system to another using linear measurement systems
		Define parallel and perpendicular lines and types of angles
		Describe types of simple plane figures, including area calculations for triangles and quadrilaterals
		Apply the components of a circle to finding its circumference, area, and diameter
		Areas & Volumes of Solids
		Calculate volumes and surface areas of rectangular objects, cylinders, and spheres
		Convert commonly used volume units
		Calculate the volume of a rectangular prism
		Calculate the surface area and volume of a cylinder
		Calculate the surface area and volume of a sphere