

APPROVED VERSION FOR DISTRIBUTION



PE 4th Class Curriculum

Curriculum Version: 2024.1

Developed in accordance with
Syllabus Version dated: Nov 2022

This curriculum document is prepared by IPECC and is intended to elaborate on the information found in the SOPEEC / ACI syllabi.

The SOPEEC / ACI syllabi are the official governing document for SOPEEC examinations. To view the official SOPEEC / ACI syllabi, refer to the SOPEEC website, www.sopec.org.

The curriculum documents are developed and approved by IPECC members as a reference document for SOPEEC examinations. These documents are posted on the IPECC website, www.ipecc-canada.ca.

Note that this curriculum document is designed to exactly mirror the layout of the syllabus. Any deviation from the list format and contents of the syllabus is considered an error that must be remedied by IPECC.

To this end, the syllabus statements are printed in this document as a series of colour-coded headers, with indents demarking the various list levels of the syllabus.

The only information that is ADDED by the curriculum document is the curriculum objectives. These are displayed in WHITE cells, as the lowest list items. The curriculum objectives are numbered in order, with this order assigned by IPECC.

NOTE: The 4th Class curriculum contains a section labelled "EXTRA." The material therein is a suggested pre-study set of materials. Basic mathematics is no longer explicitly examined by SOPEEC, but mathematical concepts are still frequently applied within the study materials. Without basic math skills the learner will face challenges with the topics of applied mechanics, chemistry, thermodynamics, materials, electricity, and boiler combustion.

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EXAM PART A
A. Elementary Mechanics and Dynamics
01. Perform basic calculations and define basic terms used in the study of mechanics
01. Define mass, force, acceleration, velocity, and weight
02. Perform simple calculations involving force, pressure, work, power and energy
02. Perform calculations using forces and moments, and determine whether or not a system is in equilibrium
01. Define the " moment" of a force and its units
02. Determine the direction and calculate the magnitude of the moment of a force
03. Define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency.
01. Define the term simple machine and apply to calculations of mechanical advantage, velocity ratio and efficiency of simple machines
04. Define and identify scalar and vector quantities and solve simple vector problems graphically
01. Define scalar and vector quantities as they apply to drawing vector diagrams
05. Define speed, velocity, distance, displacement, and acceleration and solve simple linear problems involving these terms
01. Solve distance, displacement, speed, and velocity problems
02. Draw graphs of velocity as a function of time
03. Define acceleration state its units, and solve simple acceleration problems
04. Apply mathematical formulae relating acceleration, velocity, distance and time to solve problems
06. Define force, work, pressure, power and, energy and perform calculations involving the relationships between these mechanical terms
01. Perform calculations involving force and work
02. Perform calculations involving gauge, atmospheric, and absolute pressure
03. Perform calculations involving power and different forms of mechanical energy
07. Describe friction and solve problems involving friction on a horizontal plane
01. Apply the laws governing the types of friction
02. Apply the coefficient of friction to problems involving forces on a horizontal plane
08. Explain the following:
a. The physical properties of materials and how these properties affect the materials behaviour when external forces are applied
01. Describe the characteristics of materials, including elasticity, stiffness, plasticity, ductility, toughness, brittleness, and hardness
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
01. Calculate stress including tensile, compressive, and shear stresses within rigid body members due to external loads
02. Calculate the strain of members under load
09. Explain the common examples of power transmission systems, including speed changes, transmitted power and efficiency
01. Calculate pulley speeds, transmitted power, and efficiency of belt drive systems
02. Calculate gear speeds for gear and chain drive systems
B. Elementary Chemistry and Thermodynamics

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10. Explain basic chemistry principles, basic types of matter and their properties
01. Differentiate among the physical states of matter
02. Differentiate between chemical and physical changes in matter
03. Classify matter as either a type of mixture or a pure substance
04. Describe the purpose and uses of the periodic table using the parts of an atom
05. Describe the three main ways atoms bond together: covalent, ionic, and metallic bonding
06. Discuss chemical equations and their purpose
07. Perform simple stoichiometric calculations
08. Demonstrate how unstable compounds are combined to make stable compounds
11. Explain the principles of thermodynamics, including the laws of thermodynamics
01. Define the first two laws of Thermodynamics
02. Define heat and specific heat, and perform sensible heat calculations
03. Describe the expansion of solids and liquids
12. Explain the modes of heat transfer and theory of operation of heat exchangers
01. Describe the three modes of heat transfer with reference to heat exchangers
02. Discuss the general design and construction of typical heat exchangers
03. Describe heat transfer fluids and how they affect the operation of a heat exchanger, including fouling, leakage and vapour locking.
04. Describe heat exchanger inspection, maintenance, and operation, including placing them in service and removing them from service
13. Describe the principles of the thermodynamics of steam and the associated terms
01. Describe heat as it relates to steam, water, and ice
02. Explain the various columns of the steam tables
03. Explain the thermodynamic principles of steam, using the steam tables
C. Jurisdictional Legislation, Codes and Standards for Power Engineers
14. Describe the purpose of Jurisdictional acts and regulations with respect to boilers and pressure vessels for Power Engineers.
01. Describe how the Power Engineering profession is regulated in Canada
02. Explain the purpose and scope of your Jurisdictional Act and Regulations pertaining to Power Engineering and Pressure Equipment.
03. Explain the purpose and intent of the Regulations governing Power Engineers and Pressure Welders.
15. Describe the purpose of Codes and Standards with respect to boilers and pressure vessels and piping for Power Engineers.
01. Discuss the history of how codes and standards became necessary in the pressure equipment field
02. Explain the Content and use of the CSA-B51 Boiler, Pressure Vessel, and Pressure Piping code
03. Explain the Content and use of the CSA-B52 Mechanical Refrigeration Code
04. Explain the content and use of ASME Boiler and Pressure Vessel Code (ASME BPVC) Section I Power Boilers.
05. Explain the Content and use of ASME BPVC Section VII--Recommended Guidelines for the Care of Power Boilers
06. Explain the Content and use of ASME BPVC Section IV--Rules for Construction of Heating Boilers

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07. Explain the content and use of ASME BPVC Section VI - Recommended Rules for Care and Operation of Heating Boilers.
08. Explain the purpose, intent, and limitation of ASME CSD-1 (Controls and Safety Devices) Standard
D. Power Plant / Heating Plant Safety
16. Describe general plant safety in Power, Heating, Pressure and Industrial plants that employ Power Engineers
01. Discuss the cost and effects of workplace accidents
02. Describe the basic hazards that may be in an energy plant, and the basic Personal Protective Equipment that may be required
03. Define, give examples of, and describe common power house hazards.
04. Describe Industrial health and safety management system(s)
05. Describe Hazard Assessment and Control programs
17. Describe the common safety programs that are generally applied in plants
01. Describe common occupational health and safety (OH&S) programs found in most plants
02. Describe industrial safety programs in which Power Engineers may require additional training.
03. Discuss safe work permits
04. Describe methods of equipment isolation and lock out
18. Describe the procedures for safe storage and handling of dangerous materials
01. Discuss the WHMIS system
02. Discuss the essential components required in the WHMIS systems
03. Describe the safe handling and use of gas cylinders in an energy plant (Power Plant)
04. Discuss the safe handling of Hydrocarbons
19. Explain fire safety in a plant
01. Discuss the theory, terminology, and the life safety issues associated with fires
02. Explain the five classes of fires and describe the types of fire extinguishing media and how they act on these fires
03. Explain fire prevention
04. Discuss fire prevention methods for the five classes of fires
20. Describe the causes of, extinguishing methods and preventive measures for fires
01. Describe the construction and operation of various types of portable fire extinguishers
02. Discuss the inspection and maintenance requirements for portable fire extinguishers
03. Describe the types, layout, and operation of standpipe and sprinkler systems
04. Discuss the maintenance requirements of standpipe and sprinkler system components
05. Describe the purpose, operation, and maintenance of fire pumps
E. Environment
21. Explain how the environment is related to the operating plant.
01. Describe four important Biogeochemical Cycles that operate within the environment
02. Describe typical interdependencies seen among elements within an "ecosystem."
03. List the types of impacts that operating facilities can have on the environment
04. Describe the alert processes related to environmental problems of plants
05. Explain the importance of "attitude" in limiting environmental impacts of plants
06. Describe the long term environmental impacts after the decommissioning and abandonment of plants
22. Explain how gas and noise emissions affect plant operation

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01. Identify the sources and effects of common gases and vapours that have an adverse environmental impact
02. Identify the common greenhouse and acid rain causing gases and describe their effects
03. Describe the common methods for monitoring and reducing gaseous pollutants
04. Describe the effects of noise pollution and methods of identifying, measuring, and controlling it
23. Explain how liquid and solid emissions affect plant operation
01. Describe the sources and effects of solid pollutants from energy plants
02. Describe the theory of operation of separators/collectors and monitoring of flue gas particulates
03. Describe the disposal methods of solid waste from energy plants
04. List sources and effects of liquid waste and thermal pollution.
05. Describe the preventive measures that can be taken to prevent liquid and thermal pollution
06. Describe methods of liquid waste disposal
F. Material and Welding
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
01. Describe the mechanical properties of materials
02. Describe the various types of ferrous materials
03. Describe the various types of non-ferrous materials
25. Describe the welding processes that are relevant to the plant and Power Engineer
01. Describe non-fusion welding process, equipment used, and methods
02. Describe forge and oxy-fuel fusion welding processes and cutting processes
03. Describe metal arc welding processes
04. Describe heat treatment of welds
05. Describe the types of weld joints used in pressure vessel construction
06. Describe the additional construction components required for pressure vessels to ensure structural integrity and "access"
26. Describe the inspection and testing methods of welds and materials used in plants
01. Describe common weld defects.
02. Describe the process of Visual Testing of welds
03. Describe the process of Penetrant Testing for detecting weld or material defects
04. Describe the process of radiographic weld testing
05. Describe the process of ultrasonic weld testing
G. Piping and Valves
27. Describe the basic types of piping, piping connections, supports and drainage devices used in the industry
01. State the applications for the most common materials and identify the sizes of commercial pipe
02. Describe methods of connection for screwed, flanged and welded pipe; identify fittings and their markings
03. Describe methods and devices used to allow for pipe expansion and support
04. 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
05. Explain the requirements, materials and methods for insulating pipe

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28. Describe the design and uses of the valves designs most commonly used in industry plants and on boilers
01. Describe standard valve designs
02. Describe the design and operation of specialized boiler valves
03. Describe a typical steam pressure reducing station, and the design and operation of steam system pressure-reducing valves
04. Discuss valve details, including materials of construction and identification markings
05. Describe typical valve maintenance requirements
H. Electricity
29. Describe the concepts of basic electricity and perform simple AC & DC calculations using voltage, current, resistance and power
01. Describe the atomic structure of matter and its relationship to electricity
02. Describe basic electrical circuits
03. State Ohm's Law and apply it to single resistor circuits
04. Apply Ohm's Law to series resistance circuits
05. Apply Ohm's Law to parallel resistance circuits
06. Explain Electrical conductors and insulators using examples
07. Explain the factors that affect resistance mathematically
08. Calculate the power developed in an electrical circuit
30. Describe the basic principles of magnetism as it relates to electricity.
01. Describe magnetism and the relationship between magnetism and electricity
02. Describe the relationship between electricity and magnetism in an electrical generator
03. Describe the relationship between electricity and magnetism in an electric motor
31. Describe the designs and uses of electrical metering devices.
01. Describe electrical meters and their uses
02. Describe how voltage, current, and resistance are measured in an electric circuit
03. Describe the construction and operation of a kilowatt hour meter
32. Describe the operating principles of the various types of AC and DC motors and generators.
01. Describe the construction and operation of DC generators and motors
02. Describe the construction and operation of AC generators (alternators) and motors
03. Interpret the information on a motor nameplate
04. Perform basic calculations relating to power factor and power factor correction
33. Describe the operating principles of electrical transformers.
01. Describe the principle of operation of transformers
02. Perform basic transformer calculations as they relate to the construction and operation of single phase transformers
03. Describe the construction and operation of three-phase transformers
04. Discuss special transformer types and their applications
05. Discuss transformer cooling, safety, and Maintenance
34. Describe an electrical distribution system and safe operation
01. List and describe the standard types of electrical voltage systems
02. Interpret electrical single line diagrams and circuit symbols
03. Describe the major components of an electrical distribution system
04. Describe the function and operation of fuses and circuit breakers
05. Describe the function and operation of alternate power supply system equipment
I. Energy Plant Instrumentation and Controls
35. Describe the overall purpose and function of plant instrumentation and control systems

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01. Describe the concept and basic components of a control loop
02. Describe the various means by which control signals are transmitted and the function of transducers
03. List and describe the types of instruments that are not control loop components
36. Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition
01. Describe the types of pressure sensing and measuring devices
02. Describe the types of level sensing and measuring devices
03. Describe the types of flow sensing and measuring devices
04. Describe the types of temperature sensing and measuring devices
05. Describe the types of humidity sensing and measuring devices
06. Describe the types of gas (composition) sensing and measuring devices
37. Describe the basic types and functions of transmitters, recorders, controllers, and control actuators
01. Describe the construction and operational principles of instrumentation transmitters
02. Describe the construction and operational principles of instrumentation indicators and recorders
03. Describe the construction and operational principles of instrumentation controllers
04. Describe the construction and operational principles of final control elements
38. Describe the operation of programming controls for boilers and discuss testing and maintenance procedures for these controls
01. Discuss how programmable controllers work and how they act as sequencers for equipment
02. Describe applications of programmable controllers
03. Explain the HMI (human machine interface) and purpose of touchscreen displays, functions, and alarm handling
39. Describe the design and operation of electronic control systems
01. Discuss electronic process control systems
02. Describe computers and how they operate within control systems
03. Describe the applications of computerized control systems and plant computers
40. Describe the design and operation of electrical control systems
01. Describe the basic construction and operation of various electric control system components
02. Describe the function of control devices in electric control systems
03. Explain the operating sequence of basic electric control circuits
J. Plant Communications
41. Describe how to setup plant and equipment sketches, and how to complete a plant line tracing diagram
01. Create sketches using centre lines and dimensioning
02. Recognize standard views of an object
03. Recognize cross hatching methods in sectional drawings
04. Identify common drawing symbols and lines used in plant system trace drawings
05. Complete a plant line trace drawing.
42. Describe the common types of diagrams used in plants
01. Explain the layout of plant diagrams
02. Explain the use of process flow diagrams (PFDs)
03. Explain the use of piping and instrumentation diagrams (P&IDs).

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04. Explain the use of general arrangement, block plans, and equipment diagrams.
43. Describe the different types of and proper use of plant communication systems
01. Discuss effective written and verbal communication skills, including the use of two-way radios
02. Describe the legal documentation requirements for Power Engineers, including log books and log sheets
03. Discuss the elements of Maintenance Management Systems, including work requests and work orders
04. Discuss the purpose, revision, and control of Standard Operating Procedures
05. Discuss updating procedures for Piping and Instrumentation Diagrams
K. Boilers
44. Describe the historical development of boilers, boiler design, components and configuration
01. Describe the history of boiler applications, design, and modern boiler improvements
02. Describe Packaged Boilers
03. Describe the construction of field assembled and field erected boilers
04. Describe components and design aspects common to all boiler vessels
45. Describe the design, components and characteristics of firetube boilers
01. Differentiate the Scotch Boiler from the other firetube boilers, and describe its development history
02. Describe circulation patterns in firetube boilers
03. Discuss construction details of firetube boilers
46. Describe the design, components and characteristics of watertube boilers
01. Describe the design and operating principles of watertube boilers
02. Describe watertube boiler components
03. Explain the design and application of packaged watertube boilers
04. Describe the design, construction, and components of large scale steam generating units
47. Explain the general design and application of electric boilers
01. Discuss the advantages and disadvantages of electric boilers
02. Describe the construction and operating principle of electric boilers
48. Describe the special designs of boilers used in heating plants
01. Describe the design of watertube and coil tube heating boilers
02. Describe cast iron boilers and vertical firetube boilers
03. Describe the construction and application of firetube heating boiler designs.
49. Describe the differences between ASME section I and ASME section IV boilers
01. Discuss the differences between Power Boiler and Heating boiler design and installation
02. Discuss the differences between Power Boiler and Heating boiler operation
L. Boiler Systems
50. Discuss the basic theory of combustion in a boiler, and the equipment used to provide proper combustion conditions
01. Discuss combustion, combustion equations, and the relationship between theoretical and excess air
02. Discuss the characteristics of solid, liquid, and gaseous fuels
03. Explain fuel and the effects of combustion on refractory materials
51. Describe the common fuel systems found in boiler systems
01. Describe solid fuel delivery systems
02. Describe the main types of solid fuel firing systems

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03. Describe gaseous fuel delivery systems
04. Describe the main types of gaseous fuel firing systems
05. Describe liquid fuel delivery systems
06. Describe the main types of liquid fuel firing systems
07. Describe flue gas analysis and how it relates to boiler efficiency
52. Describe draft and the basic equipment used to supply combustion air to a boiler furnace
01. Describe the various air streams that deliver combustion air to a furnace
02. Relate differential pressure to the creation of draft
03. Describe forced, induced, and balanced mechanical draft
04. Discuss common methods of controlling combustion air flow
05. Discuss common methods of measuring furnace pressures
53. Describe the types of feedwater systems used for boilers
01. Describe the overall layout of feedwater, condensate, and make-up water systems
02. Describe the valves used in feedwater systems
03. Describe the control strategies for single-element, two element, and three element boiler feedwater systems
04. Describe methods of supplying feedwater to steam heating boilers.
05. Explain the operation of condensate receiver make-up water controls.
06. Describe the return of condensate and the supply of feedwater to high-pressure boilers.
54. Describe the purpose, equipment and operation of blow down in boiler systems
01. Describe blowoff, blowoff equipment, and blowoff procedures
02. Describe continuous blowdown, blowdown equipment, and blowdown procedures.
03. Describe the maintenance and Repair of blowoff systems
55. Describe the purpose, equipment and operation of fireside cleaning in boiler systems
01. Describe common options for in-service fireside cleaning
02. Describe the construction and operation of retractable sootblowers
03. Describe the construction and operation stationary sootblowers
04. Describe shot cleaning methods

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EXAM PART B
B01. Lubrication
01. Describe the importance of lubrication and the operating principles of lubrication
01. Discuss the concept of lubrication and list the purposes of a lubricant
02. List the various classes and types of lubricants and describe their respective properties and application
03. List the properties of lubricating oils, the additives used, and their selection criteria
02. Describe the methods for basic care and maintenance of bearings and their related lubrication systems
01. Define boundary and full fluid film lubrication
02. Describe shell (sleeve) bearings
03. Describe the construction and operation of antifriction and thrust bearings
04. Describe how to clean and replace roller and ball type bearings
05. Explain the causes of bearing failure
B02. Pumps and Compressors
03. Describe the construction and operating principles of various types of pumps used in buildings and industrial plants
01. List the common pump applications
02. Define the terms associated with pump performance
03. Describe the common pumps found in plants
04. Describe maintenance procedures for efficient and reliable pump operation.
01. Discuss the components of a motor and pump assembly
02. Describe the types of shaft seals
03. Describe the standard types of mechanical seals.
04. Describe pump bearing and shaft alignment equipment and procedures
05. Describe centrifugal pump startup and priming procedures.
06. Describe positive displacement priming, startup and routine
05. Describe the construction and operating principles of the different types of compressors
01. Describe the main classifications and types of compressors
02. Describe gaseous compression systems
06. Describe the startup, operation and shut down of different types of compressors
01. Describe compressor parts and auxiliary equipment
02. Describe the construction and operation of seals for compressors
03. Describe the capacity control of compressors
04. Describe Preventative Maintenance and routine procedures for compressors
B03. Boiler Safety Devices
07. Explain the code and standards requirements, design and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels
01. Discuss the code requirements, the construction and operation of ASME Section I pressure relief valves and devices.
02. Discuss the code requirements, the construction and operation of ASME Section IV pressure relief valves and devices
03. Describe the testing and repair of Pressure Relief Valves
04. Describe the construction and operation of a temperature (Temperature and Pressure) relief device
08. Explain the design and operation of combustion safety controls on burners and boilers
01. Describe the construction and operation of burner / boiler flame failure detectors

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02. Describe burner management systems.
03. Interpret Burner operating sequence bar graphs and provide a typical sequence of startup and shutdown events
04. Compare the devices/controls that can be either operating or safety circuit
05. Describe the equipment operation process used to startup and shutdown boilers
06. Identify testing requirements for burner / boiler flame failure safety devices
07. Describe basic boiler control systems
09. Describe feedwater control methods and devices used on boilers
01. Describe the construction and operation of boiler low water level fuel cut-off equipment.
02. List the ASME and CSA code regulations regarding low water fuel cutoff devices
03. Describe direct and indirect type boiler water level indicators.
04. Describe testing and maintenance of boiler low water level fuel cutoffs
10. Describe the code and standards required and operation required fittings, along with the operating principles of fittings found on boilers
01. Explain the code references for boiler fittings
02. Describe the code requirements for pressure gauges on steam boilers
03. Describe the code requirements for boiler connections and valves on steam boilers
04. Describe the code requirements for required fittings on hot water boilers
05. Describe types of non-code required fittings used on boilers
06. Describe the trim items found on Power and Heating boilers
11. Name and describe the operating and safety controls found on boilers
01. Describe the operation of control and safety devices found on boiler fuel supplies.
02. Describe the safety controls found on boiler and burner systems
03. Discuss various operating controls for steam and hot water boilers
04. Describe testing and maintenance requirements for boiler controls
B04. Plant (Boiler) Operations
12. Describe the safe and efficient operational procedures that relate to starting up the auxiliary equipment in a boiler plant
01. Describe the basic auxiliaries that need to be checked, prepared, or placed in service before starting a boiler plant.
02. Describe the general procedures for starting a plant for the first time, or restarting after an outage or turnaround.
03. Discuss basic operating practices for starting pumps and fans.
04. Describe the general preparation for a hot water boiler startup
05. Describe the general preparation for a steam boiler startup
06. Describe the safety and housekeeping preparation requirements for boiler plant startup
13. Describe the safe and efficient operational procedures that relate to starting up boiler systems
01. Describe operating considerations when warming a cold boiler.
02. Describe how to start and cut in a hot water boiler
03. Describe how to start a single boiler steam plant.
04. Describe how to cut in a steam boiler in a multiple boiler plant
05. Describe semi-automatic burner ignition systems
06. Discuss the post startup inspection for boilers returning to service after a major outage.
14. Describe the safe and efficient operational procedures that relate to operating boilers
01. Describe the operation of a hot water heating boiler under routine conditions.
02. Describe routine steam boiler operating duties

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03. Describe emergency conditions in boiler plants and the required responses
04. Describe basic boiler troubleshooting activities
15. Describe the operational checks that need to be conducted for an operating boiler plant
01. Describe the shift-based operator responsibilities for boiler plants
02. Describe the safety device operational checks carried out on boilers
03. Describe routine maintenance activities for boiler plant operation
04. Describe the use of Standard Operating Procedures (SOPs)
05. Describe the need for boiler operating and maintenance logs and the type of information that should be recorded
16. Describe generic shutdown and layup procedures for different boilers
01. Describe hot water boiler shutdown procedures
02. Describe steam boiler shutdown and lockout procedures
03. Describe extended period layup requirements for steam boilers.
04. Describe hot water boiler extended period lay-up requirements
17. Describe the essential points and readings that need to be monitored and recorded in a plant
01. Discuss recording requirements for operating and performance conditions
02. Discuss the various systems required to conduct equipment repairs and to manage the related maintenance records
03. Describe the operational causes, consequences, and prevention of Water Hammer
04. Describe the consequences and actions required for common equipment failures
05. Describe the consequences and actions required in the event of boiler accidents
B05. Power Plant / Heating Plant Maintenance
18. Describe the safe use of common hand tools in the powerhouse
01. Describe the types and proper use of hacksaws, files, chisels, hammers, screwdrivers, and wrenches.
02. Describe the types and proper use of hand threading tools
03. Describe the types and proper use of measuring tools
04. Describe the proper layout of work and the use of layout tools
05. Describe the types and proper use of portable and fixed grinders, hand drills, drill presses and the care of drill bits
19. Describe mechanical fasteners and the safe and proper setup of equipment for hoisting and working above ground
01. Describe the requirements for setting up work platforms in general and ladders and scaffolding in particular
02. Describe the general safety precautions and calculations used when rigging equipment
03. Describe the general safety precautions used when hoisting equipment
04. Discuss the correct use and limitations of wire cable and rope, including cable attachments and rope knots
05. List and describe common types of metal fasteners, such as screws, bolts, studs, nuts and washers
20. Describe the service and maintenance required for boilers
01. Describe the general maintenance and servicing requirements for packaged firetube and cast-iron sectional boilers
02. Identify the operational procedures for wet and dry boiler layups.
03. Describe ways of detecting firetube and tubesheet leaks
04. Describe the general procedure for the removal and replacement of defective firetubes

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21. Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical and chemical boiler cleaning methods
01. List the steps and precautions to prepare a boiler for inspection
02. Describe the internal inspection of a boiler
03. Describe the methods and tools used to mechanically clean boilers
04. Describe two methods used to chemically clean boilers
B06. Water Treatment
22. Describe the general principles, methods and equipment used in preparing raw feedwater for steam production in a boiler
01. Describe typical impurities and their effects on plant and boiler water pre-treatment systems, and their treatment process
02. Describe the equipment requirements for pre-treatment of plant water systems
03. Describe water filtration and the removal of suspended solids
04. Describe the purpose, processes, and equipment used in water softening
05. Describe the theory, process, and equipment used in deaeration
23. Describe the general principles, methods and equipment used for the internal treatment of boiler water
01. Describe the types of problems and associated treatments related to internal boiler water contamination
02. Describe internal boiler feedwater chemical feed systems
03. Describe standard boiler water tests, measurement, and treatment
24. Discuss the general principles, methods and equipment used for the treatment of condensate
01. Describe condensate treatment and the effects of non-treatment
02. Describe the tests conducted on condensate
25. Discuss the general principles, methods and equipment used for the treatment of cooling tower and condenser water
01. Describe the effects of water on condensers and cooling tower materials
02. Describe condenser water systems and water treatment
03. Describe cooling tower and condenser water tests addressing common treatments
26. Describe cooling water/chilled water effects, treatment and tests
01. Describe recirculating water system corrosion and deposition
02. Describe the use of sacrificial anodes and measurement techniques to determine corrosion
03. Describe glycol system testing requirements
04. Discuss the monitoring tools, procedures and, tests used in recirculating water systems
27. Describe heating system water effects, treatment and tests.
MISSING CURRICULUM STATEMENT
B07. Prime Movers and Engines
28. Describe the conversion of heat into mechanical energy and the history of the steam engine
01. Differentiate between the terms "heat engine" and "prime mover"
02. Discuss the history of the steam engine and the expansive power of steam
29. Describe the construction and operation of steam turbines
01. Describe the principle of operation and major components of a steam turbine
02. Describe the lubrication and sealing of steam turbine shafts.
03. Describe how the rotational speed of a steam turbine is governed and controlled
04. List the steps to follow in a typical steam turbine startup and shutdown

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30. Describe the operation and maintenance of cooling towers and condensers
01. Explain the construction and operation of condensers and how they relate to the operation of cooling towers
02. Explain the principle of operation, the purpose, and the major components of cooling towers
03. Describe the construction and operation of natural draft cooling towers
04. Describe the construction and operation of mechanical draft cooling towers
05. Discuss cold climate operation for cooling towers
06. Explain typical problems, and resolutions required within the operation of cooling towers
31. Describe the application, set up, operation and maintenance required for gas turbines
01. Describe the principle of construction and operation of gas turbines
02. Identify the operational characteristics of gas turbines
03. Describe regeneration and combined steam-gas turbine operating cycles
04. Describe the key elements of gas turbine startup, operation, and auxiliaries.
32. Describe the application, construction, and operation of internal combustion engines
01. Discuss the fuels used in internal combustion engines
02. Describe the working cycles of the 4-stroke and 2-stroke spark ignition engines
03. Describe the working cycle of the 4-stroke compression ignition (diesel) cycle.
04. Describe the construction of basic spark and compression engines.
05. Explain the basic operating considerations for diesel engines
B08. Auxiliary Building Systems
33. Explain lighting systems and some of the basic design considerations for lighting a space
01. Describe the common types of lighting equipment and systems
02. Discuss the different types of artificial light sources
03. Explain the various methods of lighting control
04. Describe the general requirements and criteria for emergency lighting in buildings
05. Discuss the interrelationship between lighting, air conditioning, and energy conservation in buildings
34. Explain the various water supply systems used in buildings
01. Describe the cold water distribution system in buildings and plants
02. Describe the hot water distribution system in buildings and plants
03. Describe the construction and operation of building system hot water heaters, including temperature regulation
04. Describe the construction and operation of water system protective devices in buildings
05. Explain what is meant by "backflow prevention" and describe the common methods used
06. Describe the maintenance requirements for the components in a building water distribution system
35. Describe the design and components of various sanitary drainage systems used in buildings
01. Describe the overall layout of building drainage systems
02. Describe storm water drainage systems for buildings
03. Describe how surface runoff is managed in order to minimize environmental impact.
B09. Refrigeration
36. Explain the basic concept of refrigeration and refrigerants
01. Explain the fundamentals of refrigeration
02. Describe the cycle of operations in a vapour compression refrigeration system
03. Explain how the operating temperatures and pressures are selected and related for a vapour compression refrigeration system.

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04. State how the capacity of a refrigeration system is described and how refrigeration tables are used to calculate system performance
05. Describe how refrigerants are classified
06. Describe the thermodynamic properties of refrigerants
07. Describe the properties of refrigerants relating to miscibility, leakage tendency, odour, moisture reaction, toxicity, and flammability
08. Describe the safety concerns of common refrigerants, such as R 717, CFC's and HCFC's
37. Describe the operating principles, operation and maintenance of compression refrigeration systems
01. Describe the basic layout of compression refrigeration systems
02. Distinguish between direct and indirect refrigeration systems
03. Describe the layout of packaged refrigeration systems and the role of a refrigeration economizer
04. Describe the special types of Refrigeration Compressors, and how regular compressors are adapted for refrigeration use
05. Describe the special designs of refrigeration system evaporators and condensers
06. Discuss maintenance requirements of refrigeration systems on a yearly, monthly, bimonthly, or weekly servicing.
07. List the steps for adding oil to an in-service refrigeration compressor
38. Describe the purposes and operating principles of the operational and safety controls on a refrigeration system
01. Describe the special application of controls in a refrigeration system
02. List the safety shutdown devices specific to centrifugal compressor water chillers
03. Describe typical refrigeration system safety shutdown devices
04. Describe the construction and operation of compression refrigeration cycle expansion valves
05. Describe the different methods used to control evaporator capacity.
06. Describe the different methods used to control the capacity of refrigeration compressors
07. Discuss refrigeration auxiliaries
08. Identify refrigeration system leak tests procedures
09. Describe how a refrigeration system is dried and charged prior to start-up
10. Describe the start-up and shutdown procedure for a compression refrigeration system
11. Describe operational log sheets and preventative maintenance procedures for refrigeration systems
12. Describe how a refrigeration system is purged of non-condensable gases
13. Condenser operation and maintenance (from 38a)
14. Explain typical problems and resolutions related to refrigeration systems.
39. Describe the operating principle, maintenance and operation of absorption refrigeration systems
01. Describe the basic absorption system, comparing the differences to the compression system
02. Describe the theory and operation of an ammonia absorption refrigeration system
03. Describe the theory and operation of a lithium bromide absorption refrigeration system
04. Explain the operation of absorption refrigeration systems with respect to crystallization and dilution
05. Describe the major parts and systems of an absorption system, including: heat exchanger bypass system, pump motor lubrication and cooling system, and purging system.

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06. Describe the startup and shutdown procedures for an absorption refrigeration system
07. Describe the preventive maintenance that should be performed on an absorption refrigeration system
08. Explain typical problems and resolutions related to an absorption refrigeration system
B10. Heating Ventilating and Air Conditioning
40. Explain the methods and techniques for conditioning air for human comfort and health
01. Discuss the process to condition air for human comfort and health
02. List the categories and functions of HVAC systems
03. Describe the operation of air handling units
04. Define the terms humidity, relative humidity and dewpoint
05. Define the terms dry-bulb temperature, wet-bulb temperature, wet-bulb depression, and how they relate to relative humidity.
41. Explain the equipment and principles of humidification
01. Describe the general purpose and principles of humidification
02. Describe residential and warm air types of humidifiers
03. Describe industrial and commercial types of humidifiers
42. Describe the air flow behaviour and movement of air through distribution systems
01. Discuss the theory of air flow and pressure conversions
02. Describe the major types of air handling fans, their construction, and operation
03. Interpret fan performance curves
04. Describe fan motors, drives, and belt guards
05. Describe fan volume controls
43. Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems
01. Explain the difference between natural and mechanical ventilation
02. Describe the various contaminants found in air
03. Describe the types of air cleaning devices used in industrial/commercial buildings
44. Describe the designs and components of duct systems used in air conditioning
01. Explain how air duct systems are classified
02. Describe air duct materials, system layout, fabrication and installation
03. Describe air duct leakage
04. Identify the types of liners, dampers, and louvres used in air duct systems
05. Discuss terminal air distribution devices, and the principles of diffusion, induction, entrainment, and aspiration.
45. Describe the various types of coils used in HVAC systems, and their operation
01. Explain how steam, hot water and Glycol coils are sized, configured and operated to reduce the chance of freezing
02. Describe the installation recommendations for coils, piping, steam traps, control valves, air vents, and vacuum relief devices
B11. Heating and Cooling Systems
46. Describe the operating principles and maintenance procedures of steam heating systems and the components of these systems
01. Describe the construction and operation of steam heating system devices used to transfer heat from the steam to a heated space
02. Describe the auxiliary equipment used in a steam heating system, including air vents, radiator valves and traps, and condensate return equipment
03. Describe standard types of piping and equipment layout for steam heating systems

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04. Describe the general operation and maintenance of steam heating systems
05. Explain typical problems, and resolutions in the operation of steam heating systems
47. Describe the various designs of hot water heating systems, as well as their equipment and operation
01. Describe the standard piping and circulation layouts of hot water heating systems
02. Compare the advantages and disadvantages of hot water and steam heating systems
03. Describe various types of special hot water heating systems
04. Describe the purpose and function of standard hot water heating system accessories
05. Explain how the location of the hot water circulating pump and the expansion tank are determined.
06. Describe the routine operation of hot water heating systems including cleaning, filling, starting, and use of glycol
07. Explain typical problems, and resolutions in the operation of steam heating systems
48. Describe the common heating systems that a Power Engineer may encounter
01. Describe natural gas fueled warm air heating systems
02. Describe the recommended maintenance procedures for warm air heating and ventilating systems
03. Discuss the concept, application, construction, and operation of infrared heaters
04. Discuss the different methods of electric heating, and the advantages and disadvantages of electric heating systems as compared to other types
49. Describe central, Unitary and Combined types of HVAC systems
01. Describe the general layout and operation of unitary air conditioning systems.
02. Describe the general layout and operation of central air conditioning systems.
03. Describe the general layout and operation of combined air conditioning systems.
04. Discuss how HVAC systems should be operated under different situations
50. Describe heat gains and losses and the common methods of recovering energy from the system
01. Define heat transmission terminology
02. Describe heat gain and heat loss analysis in a building or plant
03. Describe the general principles of HVAC heat recovery
51. Describe the control systems strategies used in HVAC systems
01. Describe a basic ventilation control strategy for HVAC systems
02. Describe heating control strategies for HVAC systems
03. Describe humidification, dehumidification and cooling control strategies for HVAC systems
04. Describe volume control with static pressure regulation for HVAC systems
B12. Types of Plants
52. Identify steam-related processes in some common types of plants that employ Power Engineers
01. Identify standard Thermal System pathways and segments commonly used in plants
02. Identify Equipment and Processes in Heat Transfer Fluid (HTF) heating systems
03. Identify the main thermal processes used in oil refining industries
04. Describe the main processes used in Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation (CSS)
05. Identify thermal processes used in gas separation and compression plants
06. Identify the main Steam/Boiler Processes used in Wood and Biomass Processing Plants
07. Identify the Important Thermal Processes used in Food Production and Preservation

08. Identify the Common Processes and Equipment used in Metallurgical Processing Plants

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EXAM PART *NOT TESTED*	
The following is a suggested pre study set of materials. Basic mathematics is no longer examined by SOPEEC, but it is used in many units within the study materials. Without basic math skills the learner will have problems with the topics of applied mechanics, chemistry, thermodynamics, materials, electricity, and boiler combustion.	
01. SI Units	
01.	Describe basic SI units matching associated symbols for unit prefixes
02.	Perform unit analyses in simple problems
03.	List derived SI units and their associated symbols
04.	Perform conversions between SI and Imperial units
02. Basic Arithmetic Operations	
01.	Add and subtract integers
02.	Multiply and divide whole and decimal numbers
03.	Perform arithmetic operations involving combinations of addition, subtraction, multiplication, division, and powers in the proper order of operation
03. Fractions, Decimals & Percentages	
01.	Identify proper and improper fractions and mixed numbers
02.	Add, subtract and multiply fractions reducing them to the lowest terms
03.	Convert fractions to decimal numbers and decimal numbers to fractions
04.	Analyze percentage problems
04. Ratio & Proportion	
01.	Convert ratios of one quantity to another quantity
02.	Solve word problems involving ratios and proportions
05. Equations & Transposition	
01.	Solve equations and word problems
06. Lengths, Lines & Simple Plane Figures	
01.	Convert measurement units from one system to another using linear measurement systems
02.	Define parallel and perpendicular lines and types of angles
03.	Describe types of simple plane figures, including area calculations for triangles and quadrilaterals
04.	Apply the components of a circle to finding its circumference, area, and diameter
07. Areas & Volumes of Solids	
01.	Convert commonly used volume units
02.	Calculate the volume of a rectangular prism
03.	Calculate the surface area and volume of a cylinder
04.	Calculate the surface area and volume of a sphere