First Class (Edition 2)
Course Outline with Outcomes

The following outline directly address the SOPEEC 2012 Canadian Syllabus for First Class, dated October 2012.

Content

Chapter 3 Steady Flow Process Calculations

Learning Outcome

Perform steady flow process calculations for vapours and gases.

Learning Objectives

1. Describe the steady flow energy equation and calculate the work done in a steady flow process.
2. Calculate the power consumed in a steady flow process.
3. Explain the principle of conservation of energy and supersaturation as they apply to a nozzle, and calculate nozzle inlet and outlet velocities.
4. Calculate the initial dryness fraction of steam in a throttling process.
5. Using a Mollier Chart, determine the quality, enthalpy, and entropy of steam entering a calorimeter.
6. Calculate energy transfer, work done, and power produced in a steam turbine.
7. Calculate the heat lost, surface area, required cooling water flow, and heat transfer coefficient in a steam condenser.
8. Define and calculate availability and effectiveness in the context of the steady flow processes.

Chapter 4 Thermodynamics of Perfect Gases

Learning Outcome

Perform calculations for thermodynamic cycles of perfect gases.

Learning Objectives

1. Review the behaviour of perfect gases.
2. Explain Joule's law and its significance.
3. Calculate the heat added or rejected by a mass of perfect gas under changing temperature and pressure conditions.
4. Explain the isothermal cycle using a pressure-volume diagram, and calculate heat rejected and work done using a perfect gas as the working fluid.
5. Explain the reversible adiabatic cycle using a pressure-volume diagram and calculate work done, final volume, and final temperature using a perfect gas as the working fluid.
6. Calculate work done in a polytropic cycle using a perfect gas as the working fluid.
7. Using the heat energy equation, calculate the efficiency of a polytropic compression process for a perfect gas.
8. Explain the Gibbs-Dalton law, and calculate the work done and heat flow per kilogram when a gas mixture is expands.

Chapter 5 Expansion and Heat Transfer

Learning Outcome

Perform calculations for expansion and heat transfer.

Learning Objectives

1. Explain how boiler and piping design allows for thermal expansion and contraction.
2. Calculate the linear and volumetric expansion, given temperature changes.
3. Calculate heat transfer by conduction.
4. Calculate the heat flow through a compound insulated wall.
5. Calculate the thickness of insulation required to maintain a given temperature gradient.

Chapter 6 Refrigeration Calculations

Learning Outcome

Perform thermodynamic calculations for a refrigeration system.

Learning Objectives

1. Explain the Carnot Cycle as it applies to refrigeration using temperature-entropy and pressure-enthalpy diagrams.
2. Calculate the Carnot coefficient of performance of a refrigeration system and a heat pump system.
3. Calculate the refrigerating effect of a refrigeration system.
4. Calculate the coefficient of performance of a refrigeration system and a heat pump system.
5. Demonstrate graphically, using temperature-enthalpy diagrams, the effect on refrigeration capacity of using a throttle valve in place of an expansion machine, of superheating at the compressor inlet, of undercooling the condensed refrigerant, and of using a flash chamber.
6. Calculate the mass flow of refrigerant in a system.
7. Calculate the swept volume of a compressor cylinder, given its volumetric efficiency.
8. Calculate the power requirement of a refrigerant compressor.

Part A2: Principles of Applied and Fluid Mechanics (250 pages) Book 2 of 8

Chapter 1 Lifting Machines

Learning Outcome

Perform calculations for lifting machines.

Learning Objectives

1. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load for lifting machines.
2. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load of a differential pulley block.
3. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load of a worm gear and worm wheel.
4. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load of a worm-driven screw jack.
5. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load of a turnbuckle.
6. Calculate velocity ratio, mechanical advantage, efficiency, effort, and maximum load of a hydraulic jack.

Chapter 2 Energy and Momentum

Learning Outcome

Perform calculations involving potential energy, kinetic energy, and momentum of bodies in linear and rotating motion.

Learning Objectives

1. Define potential and kinetic energy.
2. Calculate the potential energy of a compressed spring.
3. Describe the behaviour of a spring-mass system and calculate the maximum compression of a spring caused by contact with a moving mass.
4. Describe the effect of friction losses on potential and kinetic energy.
5. Define linear momentum and calculate the coefficient of restitution.
6. Calculate the kinetic energy and velocity of an elastic head-on collision.
7. Define angular momentum and calculate the changes in momentum of rotating shafts.
8. Calculate the kinetic energy and velocity of a rotating shaft.
9. Calculate the time required to change the rotational velocity of a shaft.

Chapter 3 Centripetal Force and Acceleration

Learning Outcome

Perform calculations involving centripetal and centrifugal forces.

Learning Objectives

1. Calculate the centripetal acceleration of a rotating body in uniform circular motion.
2. Calculate the centrifugal force on a rotating body in uniform circular motion.
3. Calculate the tension in an attachment cord for vertically revolving masses.
4. Calculate the speed and period of a conical pendulum.
5. Calculate the positions of balancing masses to equalize centrifugal forces.
6. Calculate the stress in a rotating flywheel rim.
7. Calculate the velocity, acceleration, and accelerating force of a reciprocating component such as a piston driving, or driven from, a crankshaft.

Chapter 4 Torque and Torsion

Learning Outcome

Perform calculations involving torque and torsion.

Learning Objectives

1. Calculate angular velocity given the angular momentum of a rotating shaft.
2. Calculate strain in a solid bar under torsion load.
3. Calculate the stress at a given radius in a solid shaft.
4. Calculate torsional stress and strain in a hollow shaft.
5. Calculate modulus of rigidity and torsional resilience for a solid shaft.
6. Calculate the power consumed by torque acting on a rigid body rotating about a fixed axis.
7. Calculate maximum and mean torque for solid and hollow shafts of circular cross section.
8. Calculate the deflection of a closely coiled helical spring.

Chapter 5 Stress and Strain

Learning Outcome

Perform calculations involving stress, strain, shear forces, and bending moments.

Learning Objectives

1. Explain the behavior of stress and strain in solids.
2. Calculate single and double shear stress in a solid bar subject to oblique loading.
3. Define the modulus of elasticity.
4. Calculate stress, strain, and the equivalent modulus of elasticity for a compound bar.
5. Calculate stress due to restricted thermal expansion.
6. Calculate the elastic strain energy of a solid bar.
7. Calculate the instantaneous compression and stress of a solid bar subjected to suddenly applied and shock loads.
8. Calculate stresses in pressure vessels due to internal pressure.
9. Using the fundamental bending equation, calculate bending moment, moment of inertia, modulus of elasticity, radius of curvature, maximum stress, and location of neutral axis.
10. Compare the strengths of beams using the modulus of section.
11. Calculate the deflection of a beam under load.

Chapter 6 Static Fluids

Learning Outcome

Perform calculations involving fluids at rest.

Learning Objectives

1. Calculate the relative density of a liquid mixture.
2. Calculate the pressure indicated by a manometer.
3. Calculate the energy transmitted by a pressurized liquid.
4. Calculate the pressure and force on the surfaces of a tank containing non-mixing liquids.
5. Calculate the position of the centre of pressure of a tank containing non-mixing liquids.
6. Explain Archimedes' principle.
7. Calculate the relative density from the buoyant force on a submerged body and its true and apparent weights.
8. Calculate the tension and stress in the wire or cable supporting a submerged solid body.
9. Calculate the density of a floating body, given the volume of liquid that it displaces.

Chapter 7 Fluids in Motion

Learning Outcome

Perform calculations involving fluids in motion.

Learning Objectives

1. Explain the equation of continuity.
2. Calculate the fluid flow through a valve, given the valve diameter and lift.
3. Calculate flow through rectangular and triangular notches.
4. Calculate the total energy of a liquid in motion.
5. Calculate the pressure in a pipe given the cross-sectional area and liquid flow rate.
6. Calculate the diameter, velocity, and flow through an orifice given the coefficient of discharge.
7. Calculate flow through horizontal and vertical venturi given the discharge coefficient.
8. Compare the resistance to flow of various liquids due to their viscosity using the velocity gradient and coefficient of viscosity.
9. Explain the significance of steady and unsteady liquid flows with regard to Reynolds number.
10. Using Poiseuille's equation, calculate liquid flow in a pipe and the pressure required for the liquid flow to overcome viscosity.
11. Calculate the theoretical head imparted to water by a centrifugal pump.
12. Calculate the manometric head and efficiency, and power consumed by a centrifugal pump.
13. Calculate the power available from a hydraulic turbine.
14. Explain the design and significance of convergent and convergent-divergent nozzles and calculate the critical pressure of a steam nozzle.

Part A3: Applied Engineering Technologies (508 pages) Book 3 of 8

Chapter 1 Metallurgy

Learning Outcome

Discuss the selection, properties, and stress effects of steel.

Learning Objectives

1. Describe the structure of metals.
2. Explain the nature and significance of phase changes in iron and steel due to temperature change.
3. Explain how alloying elements affect phase changes in steel and state the major alloying elements used in steel.
4. Explain the effect of temperature on the tensile strength of steel.
5. Explain the criteria for the assessment of materials.
6. Explain what creep is, and why it is important to monitor its effects on equipment.
7. Explain the methods of stress analysis.
8. Explain failure analysis.

Chapter 2 Corrosion, Chemistry, and Processes

Learning Outcome

Explain the chemistry and processes of corrosion mechanisms.

Learning Objectives

1. Explain how atomic and molecular structures affect corrosion.
2. Explain the anodic and cathodic processes of corrosion.
3. Explain the electromotive force series and galvanic series.
4. Explain the effect of polarization
5. Explain corrosion of single metals.
6. Explain the processes of crevice corrosion and pitting corrosion.
7. Explain the process of microbiologically influenced corrosion.
8. Explain the process of stress induced corrosion.
9. Explain the processes of erosion-corrosion.

Chapter 3 Boiler Corrosion

Learning Outcome

Discuss the mechanisms of corrosion in boilers.

Learning Objectives

1. Explain the impact of corrosion.
2. Explain the agents of corrosion found in water.
3. Explain the mechanisms and significance of magnetite formation and magnetite depletion on boiler tube surfaces.
4. Explain the mechanisms and significance of economizer and superheater corrosion.
5. Explain the mechanism, identification, and significance of flue gas side corrosion of boiler components.
6. Explain the mechanism, identification, and significance of low temperature corrosion of boiler components.
7. Explain the relationship between boiler water chemistry and corrosion of copper alloys in feedwater systems.
8. Explain the mechanisms and significance of deaerator cracking and corrosion.

Chapter 4 Corrosion Monitoring and Prevention Techniques

Learning Outcome

Explain techniques used to monitor and prevent corrosion.

Learning Objectives

1. Describe the methods of monitoring and analyzing corrosion.
2. Explain the design, applications, and operation of cathodic protection systems.
3. Explain the use of protective coatings for corrosion control.
4. Describe the regulatory and safety requirements relating to corrosion monitoring.
5. Describe chemical control of corrosion.

Chapter 5 Corrosion Prevention Programs

Learning Outcome

Explain corrosion prevention programs.

Learning Objectives

1. Explain the corrosion characteristics and susceptibility of engineering materials and their selection for various purposes.
2. Describe the chemical, mechanical, and operational factors that are considered in controlling corrosion in steels.
3. Describe the chemical, mechanical, and operational factors that are considered in controlling corrosion in copper alloys.
4. Explain the risks and required precautions involved with chemical cleaning of boiler surfaces.
5. Explain the steps taken to reduce waterside and fireside corrosion during dry and wet storage of a boiler.
6. Explain the development, components, and management of a corrosion prevention program for cooling water systems, including the selection, application and characteristics of biocides.
7. Explain the development, components and management of a corrosion prevention program for piping and pressure vessels.
8. Explain the development, components and management of a corrosion prevention program for rotating equipment.

Chapter 6 Fuel Types

Learning Outcome

Discuss the characteristics and applications of coal, oil, and non-conventional gaseous and liquid fuels.

Learning Objectives

1. Explain the factors involved in the selection of primary and secondary fuel for a new installation.
2. Describe the fuel handling considerations and fuel burning characteristics for non-conventional solid fuels, including municipal waste, petroleum coke and biomass.
3. Compare the fuel burning characteristics of non-conventional gaseous fuels, including refinery gas, landfill gas, digester gas, carbon monoxide, liquid petroleum gases (LPGs) and acid gases.
4. Compare the fuel burning characteristics of black liquor.
5. Compare the physical properties and fuel burning characteristics of different grades of oil.
6. Describe the considerations for coal cleaning and blending.
7. Describe the purpose and process of coal gasification.
8. Differentiate between low heating value and high heating value fuels.
9. Describe the design and operational considerations for the use of low heating value fuels.
10. Explain the economic considerations for fuel selection for multifuel burners.

Chapter 7 Burner Design

Learning Outcome

Explain the criteria for burner design and selection.

Learning Objectives

1. Describe the general criteria for effective burner design.
2. Describe the classes of burner designs, based on the fuel in use.
3. Compare the design strategies for mixing fuel and air including: co-flow, cross-flow, flow stream disruption, and entrainment.
4. Describe the design considerations for a duct burner.
5. Sketch a typical multi-nozzle duct burner layout.
6. Describe the relationship of burner selection to furnace design.
7. Describe the relationship between coal pulverizer selection and burner design.
8. Describe burner design methods to reduce noise.
9. Explain the principle, significance, application, and design of staged combustion burners, including staged fuel flow and staged air flow burners.

Chapter 8 Combustion Optimization

Learning Outcome

Explain the considerations for obtaining optimum efficiency and operation of burners.

Learning Objectives

1. Explain the inherent assumptions and factors considered when determining combustion efficiency.
2. Explain the methods and limitations for obtaining maximum efficiency from the combustion of gaseous fuels.
3. Explain the methods and limitations for obtaining maximum efficiency from the combustion of liquid fuels.
4. Explain the methods and limitations for obtaining maximum efficiency from the combustion of solid fuels.
5. Explain the economic and efficiency factors for fuel and burner management in real time operating conditions for a multifuel system.
6. Describe the use of electronic instruments to continuously monitor combustion efficiency.
7. Explain the significance of flame shape, colour, and temperature.
8. Explain the effect of excess air on combustion stability and boiler efficiency.
9. Explain the symptoms, significance and corrective action for common combustion problems.

Chapter 9 Combustion Safety and Emissions

Learning Outcome

Discuss safety and environmental considerations in burner operation, including strategies for NO_X control.

Learning Objectives

1. Describe the requirements for safe operation of a combustion system.
2. Compare the significance of burner safety devices for different fuel types.
3. Explain the cause and prevention of furnace explosions in boilers and fired heaters.
4. Describe the processes for dust reduction in coal handling systems.
5. Describe the procedures for dealing with coal bunker and pulverizer fires.
6. Explain the effect of excess air and combustion efficiency on emissions parameters.
7. Explain pre-treatment as a strategy for NO_X reduction (fuel switching, additives, and fuel pre-treatment).
8. Explain combustion and operational modification as a strategy for NO_X reduction (low NO_X burners, staged combustion, water/steam injection, burners out of service, low excess air and air preheat and furnace temperature reduction.)
9. Explain process modification as a strategy for NO_X reduction (reduced production, electrical heating, improved thermal efficiency and product switching).
10. Explain post treatment as a strategy for NO_X reduction selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR).
11. Explain the effect on NO_X emissions of boiler design, boiler condition, and boiler loading characteristics.
12. Explain the reasons for and significance of flue gas recirculation.

Chapter 10 Water Pre-Treatment

Learning Outcome

Describe the processes used to treat raw water for power plants, including detailed chemistry where applicable.

Learning Objectives

1. Describe the mechanisms of coagulation and flocculation.
2. Describe the chemical processes and reactions of oxidation of organic contaminants.
3. Describe the chemical processes and reactions of iron and manganese removal from raw water.
4. Describe the chemical processes and reactions in a lime/soda softener.
5. Describe the chemical processes and reactions in a sodium zeolite softener.
6. Describe the chemical processes and reactions in a hydrogen zeolite softener.
7. Describe the chemical processes and reactions in a demineralizer.
8. Describe the chemical processes and reactions in a dealkalizer.
9. Describe the mechanisms of membrane technology, including chemical and mechanical cleaning methods and clean-in-place design.
10. Describe the chemical processes and mechanisms of electrodialysis (ED) and electrodeionization (EDI.)
11. Describe the chemical processes and reactions of oxygen scavenging and metal passivation.
12. Describe the methods by which silica is removed from feedwater and condensate.

Chapter 11 Internal Water Treatment

Learning Outcome

Describe the processes used to treat boiler water and condensate, including detailed chemistry where applicable.

Learning Objectives

1. Explain the principles, reactions, and control of chelation.
2. Explain the principles, reactions, and control of a coordinated phosphate program.
3. Explain the phenomenon of phosphate hideout.
4. Explain the principles, reactions, and control of a congruent phosphate program.
5. Explain the principles, reactions, and control of an equilibrium phosphate program.
6. Explain the principles, reactions, and control of an all-volatile treatment program.
7. Explain the principles, reactions, and control of a polymer treatment program.
8. Explain the principles, reactions, and control of an oxygenated water treatment program.
9. Describe the mechanism of sludge conditioning.
10. Describe the mechanism of antifoam conditioning.
11. Describe the chemical processes and reactions of condensate treatment, including corrosion prevention, deaeration and polishing.

Chapter 12 Water Treatment Management

Learning Outcome

Explain the monitoring, management, and maintenance of water treatment systems.

Learning Objectives

1. Explain the financial management of the costs and benefits of water treatment.
2. Apply raw water analysis to the selection of a water treatment system.
3. Explain monitoring and control of cycle chemistry.
4. Describe the troubleshooting process when a cycle chemistry parameter deviates from the acceptable range.
5. Describe the selection and maintenance of resins for zeolite, demineralizer, dealkalizer and condensate polisher service.
6. Describe the procedures and interpretation for tube deposit analyses.
7. Explain the inspection procedure for internal boiler components in relation to water treatment.
8. Describe a typical maintenance program for components of water treatment systems, including: water filters, clarifiers and lime-soda softeners, sodium zeolite softeners, demineralizers, mixed bed and condensate polishers, reverse osmosis units, microfiltration, electrodialysis and electrodeionization units and deaerators.
9. Describe the selection, responsibilities, and management of water treatment consultants.

Chapter 13 Non-Boiler Water Treatment

Learning Outcome

Explain the monitoring and management of potable water and cooling water treatment systems.

Learning Objectives

1. Describe the regulatory requirements for potable water quality and monitoring.
2. Describe the parameters and interpretation of potable water analyses.
3. Describe the selection and mechanism of oxidation agents.
4. Describe the mechanism of ultraviolet sterilization.
5. Explain the components and management of a cooling water treatment program.
6. Describe the use and chemistry of biocides in cooling water.
7. Describe the use and chemistry of corrosion inhibitors in cooling water.
8. Explain the use of chelants in cooling water.
9. Explain the use of threshold scale inhibitors in cooling water.
10. Explain the use of surfactants, dispersants, and biodispersants in cooling water.

Part A4: Power Plant Operations (288 pages) Book 4 of 8

Chapter 1 Electrical Energy Management

Learning Outcome

Discuss the concepts and techniques of electrical energy management.

Learning Objectives

1. Explain the concept of energy management and identify the operational factors that are included in an energy management program.
2. Describe the significance, components, responsibilities and procedure of an energy audit.
3. Explain the significance and application of power factor management, including the effects of: capacitor banks, synchronous motors, inductive and resistive loads, transformers, voltage regulation for synchronous generators and synchronous compensators.
4. Calculate capacitor ratings required for power factor correction.
5. Explain, using a sketch, the purpose, applications, design, and operation of a static uninterruptible power supply (UPS).
6. Explain the concept and significance of distributed generation, including the design implications for electrical distribution systems.
7. Describe the benefits of UPS in a distributed generation system, including the use of UPS as a bridge between utility and internal power.
8. Explain the benefits of motor-generator sets, internal combustion engines and microturbines in a distributed generation system.
9. Explain the design, operating principle, and benefits of a fuel cell in a distributed generation system.
10. Explain the purpose, components, and operation of emergency power systems, including the physical interconnection between emergency power and main power.
11. Explain the concept, significance, and management of peak load reduction, including utility contract obligations and use of internal generation.
12. Explain the concept and principles of generation load dispatch including contract obligations.

Chapter 2 Plant and Equipment Efficiencies

Learning Outcome

Explain and calculate power plant and equipment efficiencies.

Learning Objectives

1. Describe methods used to maximize efficiency of steam power plants and minimize energy losses.
2. Calculate boiler gross efficiency using input-output method and heat loss method.
3. Calculate turbine performance and efficiency.
4. Calculate the condensate savings and heat gained through improvements in condenser efficiency.
5. Describe the components and significant parameters of a typical computerized plant performance management system, including a program to reduce controllable losses.
6. Describe the efficiencies of a simple cycle gas turbine and various cycle improvements that can be made.
7. Describe different methods for waste heat recovery and the resultant improvement of efficiency.
8. Compare the inherent efficiencies of Once-Through Steam Generators (OTSG) with Heat Recovery Steam Generators (HRSG).
9. Calculate the steam generated and efficiency of a combined cycle plant, given system data.

Chapter 3 Power Plant Construction

Learning Outcome

Explain the regulations, processes, and procedures pertaining to the design, construction, and modification of plant facilities.

Learning Objectives

1. Describe the general criteria, including economics, which must be considered in determining the need for additional facilities and in deciding between new plant construction and existing plant expansion.
2. Describe the general criteria to be considered in the design of a new plant.
3. Describe the regulatory permitting processes for a construction project, including environmental feasibility study.
4. Describe a Quality Assurance /Quality Control (QA/QC) program for pressure equipment, including the process for accepting, receiving, and approving new and used vessels.
5. Describe the major considerations and steps involved in the construction of a new plant, from design to completion.
6. Explain the role of the Chief Power Engineer and regulatory inspectors in a plant construction project.
7. Explain the components and management of a construction health and safety program.
8. Explain the process of coordinating plant expansion activities with the operation of the existing plant, including tie-in of the old and new facilities.
9. Interpret, in detail, the information provided in construction drawings.

Chapter 4 Commissioning and De-Commissioning

Learning Outcome

Explain the regulations, processes, and procedures pertaining to the commissioning and de-commissioning of plant facilities.

Learning Objectives

1. Explain the sequence for commissioning a new plant.
2. Explain the detailed procedures for commissioning a boiler.
3. Explain the detailed procedures for commissioning a steam turbine.
4. Explain the detailed procedures for commissioning a gas turbine.
5. Explain the detailed procedures for commissioning a piping system.
6. Explain the detailed procedures for commissioning a large fan.
7. Describe the content and significance of a performance contract/guarantee for new equipment or a new plant.
8. Explain the specific procedures for re-commissioning a plant after a major outage.
9. Explain the obligations and liabilities of de-commissioning a plant, including regulatory requirements.
10. Explain the specific procedures for de-commissioning a plant.

Chapter 5 Retrofitting

Learning Outcome

Explain the benefits, applications, and processes of retrofitting power plant equipment.

Learning Objectives

1. Explain the considerations that are used to determine whether replacement, re-powering, retrofitting or upgrading should be undertaken.
2. Explain the regulatory requirements for modifications to equipment and systems, including pressure equipment, electrical systems, and environmental impact.
3. Explain the overall process and responsibilities when modifying or retrofitting plant systems.
4. Describe the benefits of control system retrofitting with “smart” instrumentation.
5. Describe the retrofitting methods used to improve boiler efficiency and capacity including superheater upgrades, economizer upgrades, combustion system upgrades, improved air heater seals, improved waterwall design, environmental enhancements and control upgrades.
6. Describe the retrofitting methods used to improve steam turbine efficiency including improved turbine blades and diaphragms, turbine stage additions, and improved blade tip sealing.
7. Describe the retrofitting methods used to improve gas turbine efficiency including upgrading inlet guide vanes, improved seals, tighter clearances, improved combustion liners, improved turbine blades and vanes, thermal barrier coatings, compressor blade coatings, compressor stage additions, and compressor supercharging.

Part B1: Legislation and Codes for Industrial Equipment (230 pages) Book 5 of 8

Chapter 1 Codes, Acts, and Regulations

Learning Outcome

Explain the significance and application, at the Chief Engineer level, of boiler and pressure vessel legislation and regulations.

Learning Objectives

1. Describe the typical duties of the Chief Engineer as set out in Boiler and Pressure Vessel legislation.
2. Describe the legal foundation for the boiler and pressure vessel legislation.
3. Define Statutory Delegation of Powers as they apply to the Boiler and Pressure Vessels Act.
4. Describe the authority that Safety Officers (Inspectors) have within their jurisdiction.
5. Determine what the offences and penalties are under the Act and the appeal process.
6. Describe the typical regulations under the Boiler and Pressure Vessels Act.
7. Describe the typical Codes and Standards referenced by the Boiler and Pressure Vessels Act.

Chapter 2 ASME Section 1

Learning Outcome

Demonstrate familiarity with the content of A.S.M.E. Section I, and perform calculations involving cylindrical components, openings, compensations, safety and pressure relief valves, and stays in boilers.

Learning Objectives

1. Describe the organization of ASME Section I and its application.
2. Calculate the required thickness or maximum allowable working pressure of a cylindrical shell.
3. Calculate the required thickness or maximum allowable working pressure of a seamless, unstayed dished head, flat head, and formed head.
4. Calculate the maximum dimensions of openings and the strength of compensation required for reinforcement of openings in cylindrical shells, headers, or heads.
5. Calculate the requirements for braced surfaces and support stays.
6. Calculate the required tubesheet thickness and maximum allowable working pressure for firetube and watertube boilers.
7. Calculate required wall thicknesses of plain circular furnaces, circular flues, Adamson, ring reinforced and corrugated furnaces.
8. Calculate the required size and capacity of pressure relief valves.

NOTE: The formulas, calculations, and code references found in this chapter are from the 2015 ASME BPVC, which is reproduced in part in the 2018 PanGlobal ASME Academic Extract Boiler and Pressure Vessel Code, Volume 1 and 2.

Chapter 3 ASME Section VIII and IX

Learning Outcome

Demonstrate familiarity with the content of A.S.M.E. Sections VIII and IX, and perform calculations involving cylindrical components, openings, compensations, safety and safety relief valves, and stays in pressure vessels.

Learning Objectives

1. Describe the organization of ASME Section VIII, Division 1 and its application
2. Calculate the required thickness or maximum allowable working pressure of a cylindrical shell in a pressure vessel.
3. Calculate the required thickness or maximum allowable working pressure of a seamless dished head, flat head and formed head in a pressure vessel.
4. Calculate the reinforcement requirements of openings in a pressure vessel.
5. Calculate the minimum required thickness of a cylinder using ligament efficiency.
6. Calculate the required dimensions and locations of staybolts and braced surfaces in a pressure vessel.
7. Calculate the required size and capacity of pressure relief valves for a pressure vessel.
8. Explain the significance of ASME Section IX.

NOTE: The formulas, calculations, and code references found in this chapter are from the 2015 ASME BPVC, which is reproduced in part in the 2018 PanGlobal ASME Academic Extract Boiler and Pressure Vessel Code, Volume 1 and 2.

Chapter 4 CSA B51 and B52

Learning Outcome

Describe the content and requirements, and interactions with CSA B51 and CSA B52.

Learning Objectives

1. Describe the content and requirements of CSA B51
2. Describe the content and requirements of CSA B52
3. Explain the role and interactions of regulatory authorities and the Chief Engineer with regard to CSA B51 and B52.

Chapter 5 Piping and API Codes

Learning Outcome

Explain the significance and application, at the ASME B31.1, ASME B31.3, API 510 and API 570.

Learning Objectives

1. Explain the significance and applications of ASME B31.1 Power Piping.
2. Describe the general content of ASME B31.1 Power Piping.
3. Explain the significance and applications of ASME B31.3 Process Piping.
4. Describe the general content of ASME B31.3 Process Piping.
5. Explain the significance and applications of API 510 Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair and Alteration.
6. Describe the general content of API 510 Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair and Alteration.
7. Explain the significance and applications of API 570 Piping Code: In-service Inspection, Rating, and Alteration of Piping Systems.
8. Describe the general content of API 570 Piping Code: In-service Inspection, Rating, and Alteration of Piping Systems.
9. Explain the role and responsibilities of the chief engineer with regard to the ASME and API Codes.

Part B2: Safety, Loss, and Environmental Program Management (218 pages) Book 6 of 8

Chapter 1 Loss Control

Learning Outcome

Describe the design, components, and implementation of a loss control program.

Learning Objectives

1. Explain the purpose, benefits, and typical components of a loss control program.
2. Explain the process of developing a comprehensive loss control program including the typical responsibilities and accountabilities of the program.
3. Describe the factors affecting insurance rates and the authority, role, and interaction of insurance inspectors with plant staff.
4. Describe the tools and techniques used to develop a positive attitude towards the components of a loss control program.
5. Describe the tools and techniques used to develop safety awareness in consumers.

Chapter 2 Safety Legislation

Learning Outcome

Identify the authority and application of federal and state safety legislation to the work place.

Learning Objectives

1. Explain the ultimate responsibility and requirement, in the work place, to enforce all relevant safety legislation and regulations and to respond to regulatory directives.
2. Describe the legal and ethical obligations of managers, supervisors, and employees to personnel safety.
3. Explain the significance, components, and applications of Canada Labor Occupational Health and Safety legislation.
4. Explain the authority, significance, components, and applications of provincial safety regulations, including the role and interactions of the provincial safety inspectors with plant staff.
5. Explain the requirements for safety compliance training.
6. Explain right to refuse work legislation and its legal implications.
7. Explain the authority, significance, and applications of the Workers' Compensation Board regulations, including the role and interactions of the Board with plant staff.
8. Describe the function of, and roles and responsibilities for, a worksite health and safety committee.

Chapter 3 Safe Work Programs

Learning Outcome

Describe comprehensive safe work programs.

Learning Objectives

1. Identify the components and explain the management of a comprehensive safe work program.
2. Explain the components and management of a safety training program.
3. Explain the process of hazard identification, risk assessment, and mitigation.
4. Explain the significance and procedure for safe work planning.
5. Explain the significance and procedure for safe work permits, including lockouts.
6. Explain the significance and procedure for confined space entry.
7. Explain the significance and procedure for hot work.
8. Explain the significance and procedure for excavations.
9. Explain the significance and procedure for working at heights.
10. Explain the significance and components of a contractor safety program.
11. Explain the components and management of a safety audit program, including roles, and responsibilities.
12. Explain the purpose, components, and procedure for a hazard and operability study.

Chapter 4 Emergency Response and Incident Investigation

Learning Outcome

Describe emergency response and incident investigation programs.

Learning Objectives

1. Identify the benefits and typical stakeholders of an emergency response program.
2. Explain the typical components of an emergency response program.
3. Explain the process of developing and maintaining an emergency response program, including typical responsibilities and accountabilities.
4. Explain the procedure for emergency response testing.
5. Explain the typical components of an incident reporting and investigation program.
6. Define categories of incidents.
7. Describe roles and responsibilities for incident initial reporting, investigation, final reporting, and corrective actions.
8. Explain the significance of and steps required in incident investigation.
9. Describe a system for managing incident report data, including the communication process, and its significance.
10. Apply an incident reporting and investigation procedure to a case study.

Chapter 5 Environmental Legislation

Learning Outcome

Identify the authority and application of federal and provincial safety legislation and permits.

Learning Objectives

1. Explain the ultimate responsibility and requirements to enforce all relevant environmental legislation and regulations and to respond to regulatory directives.
2. Explain the authority, significance, components, and applications of provincial environmental legislation and regulations, including the role and interactions of the provincial inspectors with plant staff.
3. Explain the authority, significance, components, and applications of federal environmental legislation and regulations, including the role and interactions of the federal environmental inspectors with plant staff.
4. Explain the significance and process of identifying and working with typical stakeholders for environmental programs – the Environmental Impact Assessment (EIA) process.
5. Explain typical compliance requirements for an environmental monitoring program, including equipment calibration and uptime requirements.

Chapter 6 Environmental Management

Learning Outcome

Explain environmental management programs, including reporting, clean-up, disposal, and reclamation.

Learning Objectives

1. Explain the purpose, significance and components of an environmental management system.
2. Describe the ISO 14000 - 14002 standards for an environmental management system.
3. Describe requirements for environmental routine, excursion and exceedance reporting.
4. Explain the compliance tests for Continuous Emission Monitoring Systems (CEMS) and the significance and procedures for Relative Accuracy Test Audits (RATA).
5. Explain the responsibilities and procedures for spill containment and cleanup.
6. Explain the components and development of an environmental audit program.
7. Explain the procedure for an environmental audit, including the roles and responsibilities for performing and responding to the audit.
8. Explain the significance, procedures, and regulatory requirements of waste segregation and disposal.
9. Identify waste streams that require special disposal procedures, including recognition of hazardous wastes.
10. Explain the significance and general components of Transportation of Dangerous Goods Act.
11. Explain the significance and general requirements of hazardous waste transportation.
12. Describe the purpose, significance, requirements, and general process of land reclamation.

Part B3: Inspection, Maintenance, and Repair Practices (268 pages) Book 7 of 8

Chapter 1 Project Management

Learning Outcome

Demonstrate the application of project management practices.

Learning Objectives

1. Define a project, the role of project management, and the makeup of the project stakeholders.
2. Identify the roles and responsibilities of a typical project team.
3. Explain in detail the project planning step.
4. Describe the common tools that are used for project planning and management, including Work Breakdown Structure (WBS), Critical Path Method (CPM), and Gantt charts.
5. Explain in detail the project execution step, including control processes.
6. Explain in detail the project completion step, including assessment and reporting.

Chapter 2 Maintenance Management Practices

Learning Outcome

Explain management practices for typical maintenance programs.

Learning Objectives

1. Describe how equipment is managed through the concept of asset management.
2. Explain the purpose, components, and management of a maintenance program including preventive, predictive and corrective maintenance approaches.
3. Explain the concepts and importance of reliability centred maintenance (RCM) in developing a maintenance program.
4. Describe the major steps in performing an RCM analysis.
5. Provide an example of how RCM is applied.
6. Explain the purpose and process of root cause failure analysis (RCFA).
7. Describe how maintenance can be optimized.
8. Describe how a plant turnaround is planned and effectively executed.
9. Explain the concept, process, and benefits of outsourcing maintenance.
10. Explain the setting up and management of short-term maintenance contracts and long-term service agreements.
11. Explain the purpose and process of maintenance planning and scheduling.

Chapter 3 Boiler Repairs

Learning Outcome

Explain quality control programs and specific boiler repair procedures.

Learning Objectives

1. Explain the National Board of Boiler Inspectors (NBBI) requirements for owner inspection and quality control programs.
2. Describe in detail the components of owner inspection and quality control programs, including roles and responsibilities, records, and reporting procedures.
3. Describe the roles, responsibilities, and personnel qualifications regarding repairs to boilers.
4. Explain the detailed procedure for repairs to cracks in boiler parts, including drums and headers.
5. Explain the detailed procedure for repairs to ruptured boiler tubes.
6. Explain the management, responsibilities, and procedures for safety valve repairs.

Chapter 4 Pressure Vessel and Piping Repairs

Learning Outcome

Explain specific pressure vessel and piping inspection and repair procedures.

Learning Objectives

1. Describe the management roles, responsibilities, and qualifications regarding repairs to pressure vessels and pressure piping.
2. Explain the concept for fitness for service.
3. Describe in detail a typical pressure vessel inspection, identifying typical problem areas.
4. Describe in detail a typical pressure piping inspection identifying common problem areas.
5. Explain the detailed procedure for typical repairs to cracks in pressure vessels.
6. Explain the methods and detailed procedures for typical repairs to corrosion in pressure vessels.
7. Explain the detailed procedure for typical repairs to cracks in pressure piping.
8. Explain the methods and detailed procedures for typical repairs to corrosion in pressure piping.

Chapter 5 Non-Destructive Examination

Learning Outcome

Explain the methods, applications, and control of non-destructive examination.

Learning Objectives

1. Explain the significance and application of ASME Section V.
2. Describe radiographic examination.
3. Describe the process of ultrasonic examination.
4. Describe the process of dye penetrant examination.
5. Describe the process of magnetic particle examination.
6. Describe the process of eddy current examination.
7. Describe the process of acoustic emission examination.
8. Explain the selection, management, and control of a non-destructive examination contractor.

Chapter 6 Rotating Equipment Maintenance

Learning Outcome

Explain specific maintenance procedures for, and typical maintenance problems of, rotating equipment.

Learning Objectives

1. Explain the typical maintenance problems of a large steam turbine.
2. Explain the procedures for inspection and overhaul of a large steam turbine.
3 Explain the typical maintenance problems of a gas turbine.
4. Explain the procedures for inspection and overhaul of a gas turbine.
5. Explain the typical maintenance problems of a large multi-stage pump.
6. Explain the procedures for inspection and overhaul of a large multi-stage pump.
7. Explain the typical maintenance problems of a large generator.
8. Explain the procedures for inspection and overhaul of a large generator.

Chapter 7 Rotating Equipment Monitoring

Learning Outcome

Describe the parameters and methods of turbine monitoring and oil analysis.

Learning Objectives

1. Describe the purpose, importance and types of rotating equipment monitoring.
2. Explain the concept and significance of turbine thermal expansion, the general principles and placement of measuring devices and the procedures to control.
3. Explain the concept and significance of turbine differential expansion, the general principle and placement of measuring devices, and the procedures to control.
4. Explain the concept and significance of turbine eccentricity, the general principle and placement of measuring devices and the procedures to control.
5. Explain the concept of vibration, including typical causes, effects, and locations of vibration in rotating equipment, and how it is measured.
6. Explain the concept and significance of turbine critical speed.
7. Explain the concept and significance of oil whirl, oil whip, and steam whirl and the design and operational considerations to counter oil whirl.
8. Describe common oil problems and their effects on rotating equipment and a typical oil sampling and testing program.

Part B4: Business and Workforce Management (270 pages) Book 8 of 8

Chapter 1 Business Management

Learning Outcome

Explain general concepts in plant budgeting, finance, accounting, and inventory control.

Learning Objectives

1. Explain the concept and significance of the following accounting terms: accounting cycle, dual entry accounting, debits and credits, accrual accounting, revenue and expenses, assets and liabilities, and debt and equity.
2. Explain the concept and significance of financial statements, including Income Statement, Balance Sheet, Statement of Retained Earnings and Cash Flow Statement.
3. Explain budget development, control and reporting processes.
4. Explain typical types of budgets and their significance, including revenue, expense, capital expenditure and production budgets.
5. Explain the components of plant department budgets.
6. Explain the significance of a cost/benefit analysis.
7. Explain the “time value of money” concept and calculate the Net Present Value (NPV) and Internal Rate of Return (IRR) of a proposed investment.
8. Calculate the Return on Investment (ROI) of a proposed investment.
9. Explain depreciation, including straight-line and declining balance depreciation, and the concept and significance of Capital Cost Allowance (CCA).
10. Describe the components and use of a typical automated inventory system.
11. Explain the purpose and operation of typical inventory management systems, including fixed-point, fixed-interval, max/min, ABC, Just In Time (JIT) and Economic Order Quantity (EOQ).
12. Explain the concepts and significance of periodic and perpetual inventory systems, Last In First Out (LIFO) and First In First Out (FIFO).
13. Describe the role of a supplier and the use of strategic partnerships in an inventory management system.

Chapter 2 Contract Management

Learning Outcome

Explain general concepts and management of contracts.

Learning Objectives

1. Explain the content and significance of a typical code of ethics of a professional association.
2. Explain the importance and application of ethical practices in the work place.
3. Define and explain the legal significance of contract, offer, and acceptance.
4. Explain the significance of contract documentation, and the rights and obligations of a contactor and contractee.
5. Compare contract types, including: fixed price; cost plus/shared risk; fixed price/cost plus incentive; bonus/penalty; time/material; product/service/resource; and enforceable/unenforceable contracts.
6. Describe methods of discharging a contract, including: agreement, performance, impossibility, operation of law, breach, failure to perform and specific performance.
7. Explain tort and its legal significance; the three basic types of torts, including: intentional, fault-based or negligent, and strict liability; the distinction between legal and ethical liability.
8. Explain due diligence and its legal and ethical significance.
9. Explain “force majeure” and its legal significance.
10. Explain what is involved in issuing and then completing a tendering process.

Chapter 3 Problem Solving and Decision Making

Learning Outcome

Explain techniques for structured problem solving and decision making.

Learning Objectives

1. Explain the importance and application of a structured decision making process.
2. Describe the eight steps in a rational decision making process.
3. Compare analytic, conceptual, directive, and behavioral decision making styles.
4. Explain the advantages and disadvantages of group decision making.
5. Describe the common methods of group decision making, including brainstorming, storyboarding, Nominal Group Technique (NGT), and the Delphi technique.
6. Apply a problem solving and decision making approach to a typical plant case study.

Chapter 4 Leadership

Learning Outcome

Discuss models of leadership and motivation.

Learning Objectives

1. Explain leadership responsibilities and the significance of an effective leadership style.
2. Explain the managerial grid and its significance.
3. Explain situational leadership and its significance.
4. Compare the concept and significance of traditional objective setting and management by objectives (MBO).
5. Compare methods of communicating goals and objectives.
6. Explain the motivation process.
7. Compare the basic models of individual motivation, including the hierarchy of needs, motivation-hygiene theory, goal-setting theory, reinforcement theory, equity theory, and expectancy theory.
8. Explain the concept and significance of the social styles matrix.

Chapter 5 Communication and Conflict Resolution

Learning Outcome

Apply principles of communication and conflict resolution in the work place.

Learning Objectives

1. Compare linear, interactive, and transactive communications and their significance.
2. Explain the common communication shortcuts and their significance, including selectivity, assumed similarity, stereotyping, and the halo effect.
3. Explain the significance and effects of conflict in an organization.
4. Describe interpersonal and intergroup conflict.
5. Explain the lose-lose, lose-win, win-lose, and win-win outcomes of conflict.
6. Explain assertiveness and cooperativeness and their significance.
7. Compare avoiding, accommodating, forcing, collaborating, and compromising as conflict resolution strategies.
8. Explain the stages in assertive behavior for conflict resolution.
9. Describe the concept, significance, responsibilities, and typical steps and tactics of a grievance process.
10. Explain the process of labour/management conflict resolution.
11. Describe the typical public stakeholders for an organization's business and the typical communication processes used in dealing with the public.
12. Explain the public concerns that an organization must address and the appropriate communication methods used in addressing them.

Chapter 6 Labour Relations

Learning Outcome

Explain principles and models in the management of labour relations and change.

Learning Objectives

1. Explain management's right and responsibilities in the enforcement of federal and provincial labour legislation.
2. Compare management interactions between union and non-union work forces.
3. Explain the concept, preparation, and tactics of collective bargaining, including the use of a problem-solving approach.
4. Explain the concepts, significance, roles, and responsibilities during conciliation, arbitration, strike or lockout.
5. Compare the benefits and significance of permanent and contingent employees.
6. Explain the purpose and process of human resource planning and capacity planning.
7. Explain the facilitation of labour relations with a contractor's workforce.
8. Describe the types of changes that occur in the workplace, the relationship between workplace change and employee attitude, the psychological costs and benefits of change, and management's role and responsibilities.
9. Explain the concept and significance of homeostasis.
10. Describe the three types of resistance to change (logical, psychological, and sociological), the potential benefits of resistance to change, and the three basic steps to overcome resistance (unfreezing, changing, and refreezing).
11. Explain the typical strategies used to build support for change, including: use of group forces, leadership for change, participation, shared rewards, negotiation, employee security, and communication.
12. Explain the purposes and processes of benchmarking.

Chapter 7 Recruitment and Employee Development

Learning Outcome

Explain principles and models in the management of employee recruitment and development.

Learning Objectives

1. Explain the purpose and components of a human resource management process.
2. Explain the legal and ethical constraints on recruitment and selection.
3. Explain the types and processes of pre-employment testing.
4. Explain the purpose, procedure, and limitations of typical interviewing techniques, including behavioral descriptive interviews.
5. Explain the significance and components of a training and development program including training standard, roles, and responsibilities.
6. Explain the significance and components of an orientation process.
7. Explain the purpose and proceeds of a needs assessment and gap analysis
8. Explain the purpose and process of competency profiling.
9. Explain the significance and selections of typical training methods, and their relationship to learning styles.
10. Explain the significance and progression and cross-training methods.
11. Explain the purpose and components of a performance management program, including coaching.
12. Explain typical models of performance reviews.
13. Explain the process of corrective and progressive discipline.

Chapter 8 Management Structures and Organization

Learning Outcome

Discuss principles of organizational structure and the application of work teams.

Learning Objectives

1. Compare the design and benefits of typical organizational structures, including: scalar, functional, tall/flat and matrix.
2. Explain the concept and significance of organizational culture.
3. Explain the significance of a team-based organizational structure and methods to develop and promote teamwork.
4. Compare the significance, benefits, and limitations of supervised and self-directed work teams.
5. Describe the characteristics and functioning of a successful work team.
6. Explain the concept and significance of cross-functional work teams.