Second Class (Edition 2.5) Part B2

Course Outline with Outcomes

These learning materials were designed to directly address the SOPEEC 2015 Canadian syllabus for 2nd Class Power Engineering Certification.

Content

Book 5 (Part B2): Combustion and Plant Systems

1. Power Plant Fuel Systems

Learning Outcome

Describe the design and operation of typical power plant systems.

Learning Objectives

1. Describe, using a sketch, the design and operation of fuel oil supply systems.
2. Describe, using a sketch, the design and operation of fuel gas supply systems.
3. Describe, using a sketch, the design and operation of solid fuel supply systems.

2. Power Plant Water and Steam Systems

Learning Outcome

Describe the design and operation of typical power plant systems.

Learning Objectives

1. Describe, using a sketch, the design and operation of feedwater systems.
2. Describe, using a sketch, the design and operation of steam distribution systems.
3. Describe, using a sketch, the design and operation of condensate systems.
4. Describe, using a sketch, the design and operation of cooling water systems.
5. Describe, using a sketch, the design and operation of waste handling systems.
6. Explain how different power plant water systems interconnect and what parameters are significant to each.

3. Measurement and Control Components

Learning Outcome

Explain the design and application of measuring devices and final control elements.

Learning Objectives

1. Describe the design, use, and placement of electrical and electronic pressure measuring devices.
2. Describe the design, use, and placement of electrical and electronic temperature measuring devices.
3. Describe the design, use, and placement of Venturi tubes, orifice plates, flow nozzles, and Pitot tubes.
4. Describe the design and use of: manometers, ring balance, force balance, and electric flow indicating mechanisms.
5. Describe the design, use, and placement of the following liquid level measurement devices: ball-float, displacement-type, hydrostatic head, electric and pneumatic level transmission, electric and magnetic type level-limit devices, and remote water-level indicators.
6. Describe the types, construction, and flow characteristics of control valves.
7. Describe the design, operation, and application of the following valve operators: solenoid, pneumatic-diaphragm, power cylinder, and electric motor.

4. Control Instrumentation Systems

Learning Outcome

Explain and apply the theory of automatic boiler, distributed control, and programmable logic control systems.

Learning Objectives

1. Describe the principle, design, application, and limitations of the following automatic control methods: proportional, proportional-plus-reset, and proportional-plus-reset-plus-rate.
2. Describe the principle, design, application, and limitations of single, two, and three-element boiler feedwater control systems.
3. Describe the principle, design, application, and limitations of superheated and reheated steam temperature control systems.
4. Describe the principle, design, components, application, and limitations of Distributed Control Systems (DCS).
5. Describe the principle, design, application, and limitations of Programmable Logic Controllers (PLC).

5. Fuels and Combustion Calculations

Learning Outcome

Perform combustion and furnace draft calculations and explain flue gas analysis.

Learning Objectives

1. Describe the nature of combustion and the different types of fuels.
2. Calculate the mass and volumetric analysis of a fuel.
3. Describe the proximate and ultimate analysis and calculate the heating value of fuel.
4. Given the results of a bomb calorimeter test, calculate the heating value of a fuel.
5. Calculate the amount of air and excess air required for combustion of fuel.
6. Explain flue gas analysis parameters and their significance.
7. Calculate theoretical draft, flue gas velocity, and stack diameter.
8. Calculate draft fan power and efficiency.

6. Firing and Draft Equipment

Learning Outcome

Explain the design, components, and auxiliary equipment of steam generator furnaces.

Learning Objectives

1. Describe steam generator furnace designs including cyclone furnaces and divided furnaces. Explain the purpose and placement of furnace arches.
2. Explain the purpose and design of separately fired superheat and reheat furnaces.
3. Explain the purpose, types, characteristics, and placement of refractory in a furnace.
4. Describe the principle, design, and application of oil, gas, and coal burners.
5. Describe the principle, design, and application of pulverizers.
6. Describe the principle, design, and application of ash and slag disposal systems.
7. Explain the significance, monitoring, and control of ash fusion temperature.
8. Describe the designs and applications of forced and induced draft fans.
9. Explain the methods which control furnace draft.

7. Combustion Control and Safeguards

Learning Outcome

Explain combustion control methods and safeguard components.

Learning Objectives

1. Describe, using a sketch, the combustion control arrangements in a steam generator.
2. Explain series, parallel, and series/parallel combustion control.
3. Explain turbine-following, boiler-following, and integrated combustion control systems.
4. Describe the operation of purge, fan failure, and flame failure interlock systems.
5. Describe the operation of flame detectors.
6. Describe, using a sketch, a typical programming sequence for a packaged boiler control system.
7. Describe the typical limiting devices and alarms for a packaged boiler combustion system.

8. Environmental Monitoring

Learning Outcome

Explain the significance of environmental parameters and methods of monitoring.

Learning Objectives

1. Explain the significance of the following air quality parameters: particulates, stack opacity, SO_2 concentration, SO_2 mass flow, NO_x concentration, NO_x mass flow, mercury, O_2, CO_2, and hydrocarbons.
2. Explain the basic principles of operation for Continuous Emissions Monitoring System (CEMS) measurement instruments.
3. Explain the general requirements for Continuous Emissions Monitoring Systems (CEMS).
4. Explain the significance of the following water quality parameters: iron, phosphorous, biochemical oxygen demand (BOD), chemical oxygen demand (COD), hydrocarbons, temperature, flow, pH, and nitrogen.
5. Explain the general requirements for wastewater monitoring.
6. Explain how data received from environmental monitoring equipment is interpreted.
7. Explain the significance of environmental monitoring equipment failure.
8. Describe the procedures used for troubleshooting environmental monitoring equipment.

9. Environmental Control Methods

Learning Outcome

Explain the methods used to remove SO_2, NO_X, CO_2, and particulates from boiler flue gases.

Learning Objectives

1. Describe the purpose, design, operation, and application of Flue Gas Desulphurization (FGD) systems.
2. Describe the purpose, design, operation, and application of Selective Catalytic Reduction (SCR) systems.
3. Explain the significance of NO_X reduction in a power plant, and the procedures and equipment used to reduce NO_X emission from a boiler and from a gas turbine.
4. Explain the purpose, effects, and application of flue gas chemical conditioning in a power plant.
5. Explain the significance, procedures, and equipment for reduction of CO_2 emission from a boiler.
6. Describe the purpose, design, operation, and application of a baghouse.
7. Describe the purpose, design, operation, and application of an electrostatic precipitator.