Second Class Edition 2.5 Part A2

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 2 (Part A2): Thermodynamics and Metallurgy

1. Heat, Expansion of Solids, and Heat Transfer

Learning Outcome

Perform calculations to determine the thermal expansion of solids and basic heat transfer properties.

Learning Objectives

1. Perform heat calculations on solids, liquids, and vapours.
2. Explain the theory of thermal expansion and solve problems using the formula for linear thermal expansion.
3. Calculate the change in the area of an object, including holes, due to a temperature change.
4. Describe the principle of volumetric expansion and perform calculations involving the change in volume of solids, due to a change in temperature.
5. Describe the three basic modes of heat transfer (convection, conduction, and radiation) and perform simple calculations.
6. Perform calculations involving heat transfer at a surface.

2. Thermodynamics of Gases

Learning Outcome

Perform calculations related to expansion and compression of perfect gases.

Learning Objectives

1. Explain the behaviours of a perfect gas and the laws that govern gas behaviour, including Boyle's Law, Gay-Lussac's Law, Charles Law, the General Gas Law, and the Ideal Gas Law.
2. Explain Dalton's Law of Partial Pressures.
3. Define and calculate specific heats under constant volume and constant pressure conditions.
4. Explain the relationship between work and heat as expressed in the First and Second Laws of Thermodynamics.
5. Calculate the work done during expansion and compression under constant pressure and isothermal conditions.
6. Calculate the work done during adiabatic expansion and compression.
7. Calculate the work done during polytropic expansion and compression.

3. Thermodynamics of Steam

Learning Outcome

Perform calculations related to properties of steam.

Learning Objectives

1. Describe the basic properties of water and steam.
2. Perform calculations involving specific enthalpy, dryness fraction, specific heat, and specific volume using steam tables.
3. Explain the principles and use of calorimeters to measure the dryness fraction of wet steam.
4. Calculate the dryness fraction of steam based on calorimeter data.
5. Calculate the internal energy of steam under given conditions.
6. Explain entropy and calculate the change in entropy for a particular water/steam process.
7. Determine steam properties using a Mollier Chart.
8. Calculate boiler thermal efficiency using test data.

4. Practical Thermodynamic Cycles

Learning Outcome

Explain the concepts and use of common thermodynamic cycles, using pressure-volume and temperature-entropy diagrams.

Learning Objectives

1. Explain the concept of a heat engine and describe the different types of heat engines.
2. Describe the Carnot cycle and calculate Carnot cycle efficiency.
3. Explain the Rankine cycle using pressure-volume and temperature-entropy diagrams and calculate Rankine cycle efficiency.
4. Explain the Otto cycle using pressure-volume and temperature-entropy diagrams and calculate Otto cycle efficiency.
5. Explain the Diesel cycle using pressure-volume and temperature-entropy diagrams and calculate Diesel cycle efficiency.
6. Explain the Brayton cycle using pressure-volume and temperature-entropy diagrams and calculate Brayton cycle efficiency.
7. Calculate the heat balance at different points in a Rankine cycle system using test data provided.

5. Metallurgy

Learning Outcome

Discuss the uses and structure of common metals.

Learning Objectives

1. Explain the study of metallurgy and the atomic and crystalline structure of metals.
2. Explain the significance of the iron-carbon equilibrium diagram.
3. Explain the purposes of, and processes used, in the heat treatment of steels.
4. Explain how to interpret metal specifications.
5. Explain typical selection of metals for process plant applications (what is selected and why).
6. Describe the composition, physical properties, and uses of copper, lead, and tin.
7. Describe the composition, physical properties, and uses of aluminum and aluminum alloys.

6. Testing of Materials

Learning Outcome

Discuss the common procedures and parameters for testing of metals.

Learning Objectives

1. Differentiate between destructive and non-destructive testing and explain the procedures and interpretation of tensile, hardness, and impact tests.
2. Explain the purpose and procedure of a Proof (Hydrostatic Deformation) Test.
3. Explain the causes and significances of welding discontinuities.
4. Explain Non-Destructive Examination, along with its applications and benefits.
5. Explain visual inspection and the procedures used.
6. Explain magnetic particle inspection and the procedures used.
7. Explain liquid penetrant testing and the procedures used.
8. Explain ultrasonic testing and the procedures used.
9. Explain radiographic testing, including interpretation of results.
10. Explain acoustic emission testing and the procedures used.
11. Explain leak and pressure testing.
12. Explain how to monitor and test metals for creep, fatigue and corrosion.

7. Corrosion of Metals

Learning Outcome

Discuss the common procedures and parameters for testing of metals.

Learning Objectives

1. Define corrosion and explain the electrochemical principles involved.
2. Explain how the environment can affect corrosion.
3. Explain the most common corrosion mechanisms.
4. Describe the predominant corrosion mechanisms that potentially affect various power plant systems and equipment.
5. Explain methods used to monitor and test for corrosion during plant operation.
6. Explain the methods used to control and prevent corrosion at the design stages and during operation.
7. Explain the main components of a corrosion failure analysis and a typical corrosion failure report.

8. Introduction to Welding Symbols

Learning Outcome

Describe how weld joints are constructed, using standard weld symbol terminology.

Learning Objectives

1. Explain the purpose of welding symbols.
2. Describe the common weld joints and weld types, including groove, fillet, plug and slot welds, with related weld terminology.
3. Recognize and describe symbols that identify weld types.
4. Identify and explain the meaning of the reference line, the arrow, and the tail in a welding symbol.
5. Identify and explain the meaning of supplemental welding symbols, not specific to the weld itself.
6. For groove and fillet welds, identify and explain welding symbols that relate to the weld configuration and joint preparation.