Second Class (Edition 2.5) Part B3

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 6 (Part B3): Electricity and Refrigeration

1. Alternating Current Theory

Learning Outcome

Explain characteristics and perform calculations involving AC circuits.

Learning Objectives

1. Explain the vector relationships between AC voltage and current.
2. Explain the significance of root mean square values for AC sine waves. Calculate root mean square and peak-to-peak values for AC sine waves.
3. Explain voltage/current relationships and calculate power in purely resistive circuits.
4. Explain voltage/current relationships in purely inductive circuits.
5. Explain voltage/current relationships in purely capacitive circuits.
6. Explain voltage and current relationships in circuits having resistance/inductance and resistance/capacitance combinations.
7. Calculate impedance, reactance, true and apparent power, and power factor in AC circuits.
8. Explain the significance of power factor and how it can be improved in AC circuits.
9. Explain the principle and significance of three-phase AC circuits, star, and delta connections in alternators, transformers and AC motors.
10. Calculate phase voltage, phase current and apparent and true power in a three-phase AC circuit.

2. Direct Current Machines

Learning Outcome

Explain the construction and operating principles of DC generators and motors.

Learning Objectives

1. Describe the construction and operating principles of a DC generator.
2. Explain the principle and application of compensating windings, interpoles and lap and wave armature windings.
3. Explain the principles, applications, and load/voltage characteristics of generators.
4. Describe the parallel operation and voltage regulation of DC generators.
5. Review the principle of DC motor operation, including torque development and back EMF.
6. Calculate torque and speed of a DC motor.
7. Explain the principle and application of shunt, series, and compound-wound DC motors including speed control.
8. Explain the principle and application of counter-E, current limit and time limit DC motor automatic starters.
9. Explain the principle and application of dynamic and regenerative braking.
10. Calculate efficiency and discuss the reasons for power losses in a DC motor and generator.

3. Alternating Current Generators

Learning Outcome

Explain the construction and operating principles of AC generators.

Learning Objectives

1. Explain the operating principles, design and construction of alternators with salient-pole and cylindrical rotors.
2. Explain the relationship between alternator speed, frequency, and number of pole pairs.
3. Describe the purpose and construction of an exciter.
4. Describe the purpose and design of alternator voltage regulators.
5. Describe alternator cooling systems, including circulating air cooling, hydrogen cooling, and stator winding cooling water systems.
6. Describe shaft sealing arrangements for an alternator.
7. Explain the theory and significance of alternator synchronization and parallel operation including the impact on power factor.
8. Explain efficiency and power losses in an AC generator.

4. Alternating Current Motors

Learning Outcome

Explain the construction and operating principles of AC motors.

Learning Objectives

1. Describe the principle of a pulsating magnetic field for single-phase AC motors and rotating magnetic field for three-phase AC motors. Describe general rotor and stator construction.
2. Describe the torque/speed characteristics of induction motors and the relationship between torque, slip and rotor speed.
3. Define full-load amps, locked rotor amps, service factor amps.
4. Describe the principles, applications, and operation of wound rotor motors.
5. Describe the principles, applications, and operation of single-phase AC motors. Include universal, shaded-pole, split-phase, capacitance-start, repulsion-start, and reluctance-start.
6. Describe the principles, applications, starting methods and operation of a synchronous motor.

5. Transformers

Learning Outcome

Explain the construction and operating principles of transformers.

Learning Objectives

1. Describe the construction of core type and shell type transformers.
2. Explain the factors that affect transformer rating.
3. Calculate load, power, iron and copper losses, and efficiency in a transformer.
4. Explain the purpose and procedures for transformer short and open circuit tests.
5. Describe the methods of cooling a transformer.
6. Describe the methods of connecting a transformer, including delta-delta, star-star, delta-star, and star-delta.
7. Explain the theory and significance of transformer paralleling.
8. Describe the applications of instrument transformers.
9. Describe the protective measures and devices used on transformers.

6. Electrical System Protection

Learning Outcome

Describe the protective devices used on alternators, motors, and electrical circuits.

Learning Objectives

1. Describe the significance of fuses and circuit breakers for circuit protection including continuous rating, interrupting capacity, and inverse time principle.
2. Describe the purpose and designs of different types of fuses.
3. Describe the operation of circuit breakers used for different voltages, including moulded-case, oil-immersed, airblast, air-break, vacuum, and SF_6 switchgear.
4. Describe the operation of switches and contactors used for different voltages.
5. Explain the purpose, and significance of protection relaying as it applies to a large alternator.
6. Explain the purpose and significance of the protection devices for a large electric motor.

7. Air and Gas Compression

Learning Outcome

Explain the construction and operation of large air compressors and compressed air systems.

Learning Objectives

1. Describe the design and application of compressors, including prime mover selection.
2. Describe reciprocating compressor designs.
3. Describe rotary compressor designs.
4. Describe centrifugal and axial compressor designs.
5. Describe the types and operation of coolers and air dryers, including desiccant types.
6. Describe the installation of a compressed air system, including all ancillary equipment and typical instrumentation.
7. Describe the regulation and control of compressors.
8. Describe the monitoring and protection devices for a compressed air system.
9. Explain the effects of altitude, air temperature, and humidity on air compressor performance.
10. Describe the monitoring, troubleshooting, and typical preventive maintenance for a compressed air system.

8. Refrigeration Systems and Equipment

Learning Outcome

Explain the construction and operation of refrigeration systems.

Learning Objectives

1. Describe the types of refrigerants.
2. Describe the principles and operation of vapour compression refrigeration systems.
3. Describe the principles and operation of absorption refrigeration systems.
4. Describe the principles and operation of multi-stage and cascade refrigeration systems.
5. Describe the principles, applications, and operation of heat pump and thermoelectric systems.
6. Describe the design of hermetic refrigeration systems.
7. Describe the design and operation of refrigeration compressors.
8. Describe the design and operation of evaporators, condensers, receivers, scale traps and dehydrators.
9. Describe the design and operation of absorbers.
10. Describe the design and operation of valves and fittings.

9. Refrigeration Safety, Control and Operation

Learning Outcome

Explain the procedures, standards, instrumentation, and controls for a refrigeration system.

Learning Objectives

1. Describe the codes and standards which apply to the design, installation, and operation of a refrigeration plant.
2. Describe the purpose and operation of the various operating, actuating, limiting and safety controls used in refrigeration systems.
3. Explain refrigeration metering devices.
4. Explain evaporator and compressor capacity controls.
5. Describe the detailed startup and shutdown procedures for a refrigeration system.
6. Explain absorption system startup and shutdown.
7. Explain leak testing, charging, purging, and compressor lubrication.
8. Describe the common operating problems and troubleshooting procedures for a refrigeration system.

10. Refrigeration Calculations

Learning Outcome

Perform refrigeration system calculations.

Learning Objectives

1. Describe the general refrigeration cycle and the application of the Carnot cycle.
2. Describe the relationship between enthalpy and pressure for a refrigeration cycle.
3. Define and calculate the refrigerating effect and the mass of refrigerant circulated.
4. Calculate the coefficient of performance for a refrigeration system.
5. Calculate the capacity of a refrigeration machine.
6. Calculate the theoretical power of a refrigeration compressor.
7. Calculate the theoretical bore and stroke of a refrigeration compressor.