# EN 338

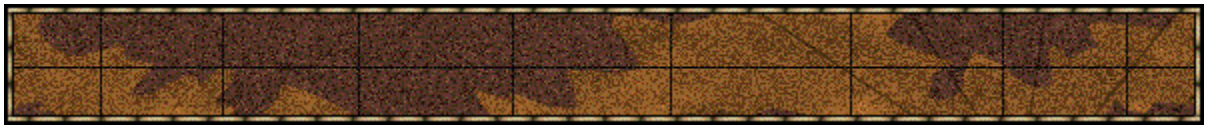
# Electricity

## 4 Credits

Instructor: Russ Webb
780 871 5484
Original Developer: Doug Stelmack
Current Developer: Russ Webb
Reviewer: Robert Collins
Created: 13/04/2017
Revised: 08/05/2020
Approval: 15/05/2020
Alternate Delivery: No

The Implementation Date for this Outline is 01/01/2021

# EN 338 Version: 4



# Electricity

## Calendar Description

Topics include AC theory such as sine wave, single phase AC circuit, three-phrase circuits and AC power. There is also in depth study of DC generators and motors, AC machines such as alternators, single-phrase motors, poly phase motors, synchronous motors and transformers.

## Rationale

This course has been developed to fill the gap of Second Class Power Engineers created by the retiring generation of power engineers.

Industry has shifted their focus from employing the lower levels of certification of power engineers to the higher levels of certification.

Upon successful completion of this program the student is eligible for a 9 month reduction in qualifying time experience granted by ABSA.

The six parts of the program are divided into 15 courses where the student has the option of registering for individual courses, Part A, Part B, or both Part A and Part B.

## Prerequisites

EN 310, EN 320, EN 410, EN 420, or Third Class Power Engineer's Certificate of Competency

## Co-Requisites

None

## Course Learning Outcomes

Upon successful completion of this course, the student will be able to

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 and calculate power in purely inductive circuits.
5. explain voltage/current relationships and calculate power in purely capacitive circuits.
6. explain voltage/current relationships in circuits containing resistance/inductance and resistance/capacitance.
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.
11. describe the construction and operating principles of a DC generator.
12. explain the principle and application of compensating windings, interpoles and lap and wave armature windings.
13. explain the principles, applications, and load/voltage characteristics of generators.
14. describe the parallel operation and voltage regulation of DC generators.
15. review the principle of DC motor operation, including torque development and back emf.
16. calculate torque, speed and current of a DC motor.
17. explain the principle and application of shunt, series, and compound-wound DC motors including speed control.
18. explain the principle and application of counter-E, current limit, and time limit DC motor automatic starters.
19. explain the principle and application of dynamic and regenerative braking.
20. calculate efficiency and discuss the reasons for power losses in a DC motor and generator.
21. explain the operating principles, design and construction of alternators with salient-pole and cylindrical rotors.
22. explain the relationship between alternator speed, frequency, and number of pole pairs.
23. describe the purpose and construction of an exciter.
24. describe the purpose and design of voltage regulators used for an alternator.
25. describe the cooling systems used for an alternator including circulating air cooling, hydrogen cooling, and stator winding cooling water systems.
26. describe shaft sealing arrangements for an alternator.
27. explain the theory and significance of alternator synchronization and parallel operation including the impact on power factor.
28. explain efficiency and power losses in an AC generator.
29. 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.
30. describe the torque/speed characteristics of induction motors and the relationship between torque, slip and rotor speed.
31. define full-load amps, locked rotor amps, service amps.
32. describe the principles, applications, and operation of single-phase AC motors. Include universal, shaded-pole, split phase, capacitance-start, repulsion-start, and reluctance start.
33. describe the principles, applications, starting methods and operation of a synchronous motor.
34. describe the construction of core type and shell type transformers.

35. explain the factors that affect transformer rating.
36. calculate load, power, iron and copper losses, and efficiency in a transformer.
37. explain the purpose and procedures for transformer short and open circuit tests.
38. describe the methods of cooling a transformer.
39. describe the methods of connecting a transformer, including delta-delta, star-star, delta-star, and star delta.
40. explain the theory and significance of transformer paralleling.
41. describe the applications of instrument transformers.
42. describe the safety controls used on a transformer including fast and slow gas detection, oil temperature alarms, low oil level protection, winding temperature alarms, overcurrent and undervoltage protection, synchronization checks, overexcitation, ground fault protection, phase sequence relays, dissolved gas monitoring, and differential protection.
43. describe the significance fuses and circuit breakers provide as protective devices including continuous rating, interruption capacity, and inverse time principle.
44. describe the purpose and designs of different types of fuses
45. describe the operation of circuit breakers used for different voltages, including molded-case, oil-immersed, airblast, air-break, vacuum, and $SF_6$ switchgear.
46. describe the operation of switches and contactors used for different voltages.
47. explain the purpose, interpretation, and significance of protection relaying as it applies to the protection of a large alternator.
48. explain the purpose, interpretation, and significance of the protection devices for a large motor.

## Resource Materials

***Required Text:***

This is material that the student is required to have to complete the course.

Power Engineering Second Class B-3 Electricity and Refrigeration, Edition 2.5 (Also acceptable is ed. 2.0). Calgary, AB: PanGlobal Training Systems Ltd.

***Reference Text*:**

The following resources are available through purchase or may be borrowed from the college library. The student may use these for supplementary instructional material, but they are not required to complete the course.

Lister, E. C., & Golding, M. R. *Electric Circuits and Machines* (2nd Canadian ed.). McGraw-Hill Ryerson Ltd., 1996 or later.

*Reeds Marine Engineering and Technology Volume 6, Basic Electrotechnology for Marine Engineers.* Revised by C. Lavers, E Kraal, S Buyers. (4th). Adlard Coles Nautical.

*Electricity One-Seven, Revised 3rd Edition*, or later. H. Mileaf, Editor-in-Chief. Prentice Hall.

NOTE: Additional resource material are provided or accessed through D2L.

## Conduct of Course

This course follows the syllabus as set out by the Standardization of Power Engineer's Examination Committee (SOPEEC) and the curriculum recommended by the Interprovincial Power Engineer Curriculum Committee (IPECC).

This course builds on the student knowledge gained through the Fourth Class and Third Class courses.

This course is delivered in a blended format through the D2L online platform. Lectures are pre-recorded videos with examples and practice questions. Where applicable, video clips are used to support the instruction. In-class sessions are used to reinforce the lessons taught online.

Each topic has online assessments in the form of quizzes, hand-in assignments and a series of online Unit Tests. A closed book Final Exam is administered at the end of the course.

## Evaluation Procedures

Lakeland College is committed to the highest academic standards. Students are expected to be familiar with Lakeland College policies related to academic conduct and academic honesty and to abide by these policies.

The marking scheme for this course is:

| | |
|---|---:|
| Assignments | 30% |
| Unit Tests | 40% |
| Final Exam | 30% |
| Total | 100% |

The contents and dates of these assessments are detailed in the course syllabus.

Marks are deducted for late assignments and quizzes. A grade of zero is assigned to missed tests and exams.

A minimum grade of 65% is required to pass this course.

The Final Exam for this course is part of the combined 2B3 Final Exam for this semester. Electricity accounts for 60% of the grade for the combined Final Exam.

A minimum grade of 50% is required on the Final Exam to pass this course.

Students seeking a qualifying time reduction from ABSA must obtain a passing grade for each course in this program, and must satisfy the 80% attendance requirement.

Students may receive a certificate from Lakeland College without the attendance requirement, but they will not qualify for steam time reduction.

## Grade Equivalents and Course Pass Requirements

***A minimum grade of C+ (65%) is required to pass this course.***

| Letter | F | C+ | B- | B | B+ | A- | A | A+ |
|---|---|---|---|---|---|---|---|---|
| Percent Range | 0-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85-89 | 90-94 | 95-100 |
| Points | 0.00 | 2.30 | 2.70 | 3.00 | 3.30 | 3.70 | 4.00 | 4.00 |

## Attendance

As a blended delivery course, attendance consists of the completion of all the online components. This includes viewing the recorded lessons and completing the assignments and tests.

In order to be successful in this course, the student should complete all the online components, but in order to obtain qualifying time reduction through ABSA, the student must complete a minimum of 80% of all the online components.

In-class sessions are used to reinforce the concepts taught in the online portion of the course. Attendance for these sessions is recommended, but not part of the attendance requirement for qualifying time reduction.

## Course Units/Topics

Alternating Current Theory

(Explain characteristics and perform calculations involving AC circuits)

Direct Current Machines

(Explain the construction and operating principles of DC generators and motors)

Alternating Current Generators

(Explain the construction and operating principles of Alternating Current (AC) generators)

Alternating Current Motors

(Explain the construction and operating principles of AC motors)

Transformers

(Explain the construction and operating principles of transformers)

Electrical System Protection

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


2602 - 59 Avenue, Lloydminster, Alberta, Canada T9V 3N7. Ph: 780 871 5700
5707 College Drive, Vermilion, Alberta, Canada T9X 1K5. Ph: 780 853 8400
Toll-free in Canada: 1 800 661 6490. Email: admissions@lakelandcollege.ca