EN450

Prime Movers & Lubrication

3 Credits

Instructor: Russ Webb
780 871 5484
Original Developer: Doug Stelmack
Current Developer: Russ Webb
Reviewer: Robert Collins
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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

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Calendar Description

This advanced course examines the principles of construction, operation and maintenance of steam turbine, gas turbine and internal combustion engines including associated ancillary equipment as well as control and lubrication support systems.

Rationale

This course has been developed to support students seeking to further their careers, as Second Class Power Engineers, with an ever increasing industry demand to replace retiring Power Engineers and operate new facilities.

Industry has shifted their focus from employing the 4th and 3rd class levels of Power Engineering certification to 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

EN310, EN320, EN410, EN420, or Third Class Power Engineer's Certificate of Competency

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to

1. explain selection criteria for a turbine application.
2. describe the design and components of steam turbine casings and casing drains.
3. describe the design and components of steam turbine rotors, blading, and diaphragms.

4. describe shaft seal designs, including stuffing boxes, carbon rings, labryinth and water seals.
5. describe the design and components of steam turbine bearings.
6. describe the ways in which steam turbines are designed to counteract thrust.
7. describe the purpose and design of expansion and anchoring components.
8. explain the principles of steam turbine nozzle design.
9. explain a steam turbine velocity diagram.
10. calculate the steam velocity and angle of entry for impulse and reaction turbine blading
11. calculate the work done on steam turbine blades and the resulting power developed.
12. calculate steam turbine Rankine cycle thermal efficiency.
13. describe the purpose, design and components of a turning gear.
14. describe the purpose, design and components of an adjusting gear.
15. explain critical speed.
16. describe the design and components of lubricating oil and jacking oil systems.
17. describe the design of speed reducing gears.
18. describe the design and components of flexible couplings.
19. describe the purpose and design of steam turbine governors and governor systems.
20. describe the purpose and design of steam turbine stop valves and control valves.
21. describe the purpose and design of steam turbine grid type of extraction valves.
22. describe the purpose and design of steam casing pressure relief systems including rupture diaphragms.
23. describe the purpose and design of steam turbine overspeed trips.
24. describe the purpose and design of steam turbine supervisory equipment.
25. describe the detailed hot and cold start-up procedures for a large steam turbine, including safety precautions.
26. describe the detailed shutdown procedure for a large steam turbine including safety precautions.
27. explain what checks are performed on a large steam turbine during normal operation.
28. sketch the flow of steam and condensate through a condensing steam turbine and a non-condensing turbine.
29. explain the preventive maintenance requirements for a large steam turbine; include shaft alignment, bearings, clearances for thrust, blades, shaft seals, correction of blade fouling, erosion and cleaning.
30. describe the purpose and procedure for static and dynamic balancing.
31. describe the principles and design of jet, air cooled, and surface condensers.
32. describe the purpose, principle and design of surface condenser support and expansion systems.
33. explain the significant parameters in condenser performance.
34. calculate condenser thermal efficiency from test data.
35. explain the procedures used to troubleshoot condenser performance.
36. explain the procedures used to backwash and clean a condenser.
37. describe the purpose, principle, and design of air ejectors and vacuum pumps.
38. describe the purpose and flow of cooling water systems.
39. describe the purpose, principle and design of cooling water intake screens, circulating pumps, cooling towers, and cooling ponds.

40. describe the purpose, principle and design of condenser atmospheric exhaust (relief) valves.
41. describe the purpose, principle and design of condensate pumps.
42. explain design, applications, and selection criteria for the different types of reciprocating internal combustion engines.
43. explain fuels and combustion processes and fuels used by internal combustion engines.
44. describe the design of internal combustion engine scavenging and supercharging arrangements.
45. describe the design and components of internal combustion engine fuel conditioning systems, injection systems, and ignition systems.
46. describe the design and components of internal combustion engine cooling systems and cooling water conditioning systems.
47. describe the purpose, design and components of internal combustion engine lubricating oil systems.
48. state the purpose and describe the control of a typical internal combustion engine including the operation of safety devices.
49. describe the detailed startup procedures for an internal combustion engine.
50. describe the detailed shutdown procedures for an internal combustion engine.
51. explain the routine maintenance and monitoring requirements for an internal combustion engine.
52. explain the major maintenance and overhaul requirements for an internal combustion engine.
53. explain the troubleshooting of combustion and engine problems.
54. explain applications and selection criteria for the different types of gas turbine engines.
55. describe the principles and design of open and closed cycle gas turbine systems.
56. describe the principles and design of combined cycle and cogeneration systems using gas turbines.
57. describe the principles and design of gas turbine regeneration, intercooling, and reheating.
58. describe the principles and design of gas turbine shaft arrangements.
59. describe the design and components of gas turbine compressors, combustors and turbines.
60. describe the design and operation of a gas turbine lubricating oil system.
61. describe the design and operation of a gas turbine fuel system.
62. describe the design and operation of a gas turbine steam or water injection system and a dry low NOx system.
63. describe the components and operation of gas turbine supervisory and control systems.
64. describe the principles and design of gas turbine protection devices.
65. describe the detailed hot and cold startup procedures for a gas turbine, including safety precautions.
66. describe the detailed shutdown procedure for a gas turbine, including safety precautions.
67. explain the routine maintenance and monitoring requirements for a gas turbine.
68. describe the major maintenance and overhaul requirements for a gas turbine.
69. explain the troubleshooting of gas turbine problems.
70. describe the methods of manufacture and the different classifications of lubricants.
71. describe the significance and measurement of lubricating oil characteristics, including viscosity, relative density, API gravity, pour point, and dielectric strength

72. explain the typical causes of lubricating oil deterioration.
73. describe the types of lubrication additives.
74. describe a typical power plant lubricating program, including a lubrication survey.
75. explain the different types of lubricating/governing, seal oil systems.
76. describe the components and operation of a typical lubricating oil purification system.
77. describe the various applications of ball-and-roller bearings and their lubrication, including bearing seals.

Resource Materials

Required Text:
Power Engineering Second Class (2015) B-1 Prime Movers (2nd ed.). Calgary, AB:

PanGlobal Training Systems Ltd.

Reference Material:
Woodruff, B., Everett, Lammers, B., Herbret, and Lammers, F., Thomas. (2005). *Steam*

Plant Operation (8th Edition) USA: McGraw-Hill

Steam/Its Generation and Use, New York: Babcox and Wilcox

NOTE: Additional resource material is 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 Power Engineering courses.

This course is delivered face to face with a component of online directed study, and includes class lectures, group discussions, demonstrations, assignments, and projects.

Cutaway models, videos, and actual equipment may be used to support instruction and demonstrations.

Desire2learn (D2L) is an online course management suite and is used as an educational resource for tracking attendance, administering quizzes, and reporting grades. Students will access D2L directly, from any computer, and may view their progress, grades and attendance at any time.

This course consists of four chapters. There is an exam at the end of each chapter as well as a midterm and final exam.

The exams consist of seven written questions of which the student chooses five questions to answer. Each question is worth 20 marks and partial marks are awarded for correct methods and partial answers.

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 and Projects	20%
Chapter Exams	20%
Midterm Exam	30%
final Exam	30%

The contents and dates of the chapter exams are determined in class.

All questions are long answer written types of questions.

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

A GRADE OF AT LEAST 50% IS REQUIRED ON THE FINAL EXAM TO PASS THIS COURSE

Those students seeking a qualifying time reduction must achieve a grade of 65% for sections A-1, A-2, A-3, B-1, B-2, B-3.

Students receive a certificate from Lakeland College indicating successful completion of the program.

NOTE: This program consists of six components; each component corresponds to one examination paper of the Alberta Boilers Association (ABSA) examination process.

The requirements for a second class power engineer consist of six ABSA examinations and 30 months of qualifying time in industry.

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

For those students seeking the nine (9) month experience qualifying time reduction granted by ABSA, a minimum attendance of 80% in all courses is required, as per the Student Handbook. If the experience credit is not desired, there is no mandatory attendance requirement.

Course Units/Topics

Steam Turbine Theory and Construction

(Explain the design and components of a steam turbine and calculate nozzle and steam velocities)

Steam Turbine Auxiliaries and Control

(Explain the purpose and design of steam turbine auxiliaries, control, and monitoring equipment)

Steam Turbine Operation and Maintenance

(Discuss procedures for operation and maintenance of a large steam turbine)

Steam Condensers

(Discuss condenser principles, performance, operation and auxiliaries)

Internal Combustion Engines: Components and Auxiliaries

(Explain the design, selection, and components of reciprocating internal combustion)

Internal Combustion Engines-Operation and Maintenance

(Describe general routine and major requirements, and detailed operating and troubleshooting procedures for internal combustion engines)

Gas Turbine Design and Auxiliaries

(Explain the design and components of a gas turbine and related auxiliaries)

Gas Turbine Operation and Control

(Describe general routine and major maintenance requirements, and detailed operating and troubleshooting procedures for gas turbine engines)

Lubrication

(Explain the components of a lubrication application and maintenance program)

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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