



REFERENCE SYLLABUS

For

FOURTH CLASS POWER ENGINEER'S

CERTIFICATE of COMPETENCY EXAMINATION

November 2022

This Syllabus will be effective November 1st, 2017



**REFERENCE SYLLABUS
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POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 1 of 8**

GENERAL INFORMATION

Introduction:

This syllabus has been approved by the Standardization of Power Engineer Examinations Committee (SOPEEC) and the Association of Chief Inspectors (ACI).

This Syllabus is intended to assist candidates studying for the New Fourth Class Engineer's Certificate of Competency Examination.

The requirements to qualify for a New Fourth Class Engineer's Examination are outlined in the applicable Jurisdictional Act and Regulations.

Recommended Study Programme:

It is recommended that, before undertaking a New Fourth Class Engineer's Examination, the candidate completes a New Fourth Class Power Engineering Course offered through a technical institute.

In addition to the foregoing course, it is recommended that the candidate becomes familiar with the publications listed in the reference material for Power Engineering Students and Examination Candidates posted on the SOPEEC web site.

Examination Instructions:

The examination consists of two papers, each of 3 hours duration. Each of the Paper A and Paper B examinations consists of 100 multiple-choice questions.

To pass a 4th Class Power Engineer's Certificate of Competency examination, a candidate must obtain at least 65% of the total marks allotted for each examination paper.

A candidate is allowed to use, and may be provided, the following items in the examination room:

- A non-technical English language dictionary provided by the local jurisdiction;
- Handbook of Formulae and Physical Constants, Steam Tables and Refrigeration Tables are normally provided;
- ASME Boiler & Pressure Vessel Codes except for Sections VI and VII;
- The 2007 (or later edition) ASME Boiler & Pressure Vessel Code Academic Extract and Supplement produced by PanGlobal Training Systems;
- ASME/ANSI B31.1 Pressure Piping Code and B31.3 Process Piping Code;
- CSA B51, Boiler, Pressure Vessel and Pressure Piping Code;
- CSA B52, Mechanical Refrigeration Code;
- Extract for CSA B51 and CSA B52 Codes;
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- Act and Regulations for the examining Jurisdiction;



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 2 of 8**

GENERAL INFORMATION

- Pens and pencils;
- Non-programmable calculator (see important note below) and
(Normally, the above items are useful for all classes of examination.)
- Drawing instruments and drawing templates.

Note

- The candidate must provide picture ID to the Examiner prior to the examination.
- No cell phone or any electronic communication devices are allowed to be brought into the examination room.
- The items referenced above must be shown to the examiner for approval.
- No other reference material is allowed.
- **Important Note:** If your calculator is programmable, you must reset it in the company of the examiner so that the examiner is sure that all memories are clear. Or the examiner may request that you remove the battery to erase all memory. This may be done during your examination time, so be aware that you may have less time to complete your exam. If the memories do not clear by resetting the calculator or by removing the battery, the calculator shall not be used. Also, if your calculator fails to function after reset or battery removal, the examiner is not responsible and you may be at a significant disadvantage.
- The information in the 1983 Edition of the ASME Boiler and Pressure Vessel Code Academic Extract is outdated. Using this 1983 Edition of the ASME Extract for any power engineering examination is not recommended. Besides using the 2007 Edition of the ASME Academic Extract and Supplement, candidates may use the current edition of the ASME Code.

Contact your local jurisdiction to find out the details.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 3 of 8**

Part "A"

A. Elementary Mechanics and Dynamics

1. Perform basic calculations and define basic terms used in the study of mechanics.
2. Perform calculations using forces and moments, and determine whether or not a system is in equilibrium.
3. Define simple machines and perform calculations relating to mechanical advantage, velocity ratio, and efficiency.
4. Define and identify scalar and vector quantities, and solve simple vector problems graphically.
5. Define speed, velocity, distance, displacement, and acceleration, and solve simple linear problems involving these terms.
6. Define force, work, pressure, power, and, energy and perform calculations involving the relationships between these mechanical terms.
7. Describe friction and solve problems involving friction on a horizontal plane.
8. Explain the following:
 - a. The physical properties of materials and how these properties affect the materials behaviour when external forces are applied
 - b. Stress and the deformation of bodies caused by externally applied forces as well as the internal forces that resist these deformations, including tensile, compressive, and shear stresses plus factor of safety
9. Explain the common examples of power transmission systems, including speed changes, transmitted power, and efficiency.

B. Elementary Chemistry and Thermodynamics

10. Explain basic chemistry principles, basic types of matter, and their properties.
11. Explain the principles of thermodynamics, including the laws of thermodynamics.
12. Explain the modes of heat transfer and theory of operation of heat exchangers.
13. Describe the principles of the thermodynamics of steam and the associated terms.

C. Jurisdictional Legislation, Codes and Standards for Power Engineers

14. Describe the purpose of Jurisdictional acts and regulations with respect to boilers and pressure vessels and piping for Power Engineers.
15. Describe the purpose of Codes and Standards with respect to boilers and pressure vessels and piping for Power Engineers.

D. Power Plant/Heating Plant Safety

16. Describe general plant safety in power, heating, pressure and Industrial plants that employ Power Engineers.
17. Describe the common safety programs that are generally implemented in plants.
18. Describe the procedures for safe storage and handling of dangerous materials.
19. Explain fire safety in a plant.
20. Describe the causes of, the extinguishing methods, and preventive measures for fires.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 4 of 8**

Part "A"

E. Environment

21. Explain how the environment is related to the operating plant.
22. Explain how gas and noise emissions affect plant operation.
23. Explain how liquid and solid emissions affect plant operation.

F. Material and Welding

24. Describe the mechanical properties of engineering materials and the ability of alloying elements to change the mechanical properties of materials, and identify nonferrous materials as used in engineering.
25. Describe the welding processes that are relevant to the plant and Power Engineer.
26. Describe the inspection and testing methods of welds and materials used in plants.

G. Piping and Valves

27. Describe the basic types of piping, piping connections, supports, and drainage devices used in the industry.
28. Describe the design and uses of the valves designs most commonly used in industry plants and on boilers.

H. Electricity

29. Describe the concepts of basic electricity, and perform simple AC & DC calculations using voltage, current, resistance and power.
30. Describe the basic principles of magnetism as it relates to electricity.
31. Describe the designs and uses of electrical metering devices.
32. Describe the operating principles of the various types of AC and DC motors and generators.
33. Describe the operating principles of electrical transformers.
34. Describe an electrical distribution system and safe operation.

I. Energy Plant Instrumentation and Controls

35. Describe the overall purpose and function of plant instrumentation and control systems.
36. Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition.
37. Describe the basic types and functions of transmitters, recorders, controllers, and control actuators.
38. Describe the operation of programming controls for boilers and discuss testing and maintenance procedures for these controls.
39. Describe the design and operation of electronic control systems.
40. Describe the design and operation of electrical control systems.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 5 of 8**

Part "A"

J. Plant Communication

41. Describe how to setup plant and equipment sketches as well as how to complete a plant line tracing diagram.
42. Describe the common types of diagrams used in plants.
43. Describe the different types of and proper use of plant communication systems.

K. Boilers

44. Describe the historical development of boilers, boiler design, components and configuration.
45. Describe the design, components, and characteristics of firetube boilers.
46. Describe the design, components, and characteristics of watertube boilers.
47. Explain the general design and application of electric boilers.
48. Describe the special designs of boilers used in heating plants.
49. Describe the differences between ASME Section I and ASME Section IV boilers.

L. Boiler Systems

50. Discuss the basic theory of combustion in a boiler, and the equipment used to provide proper combustion conditions.
51. Describe the common fuel systems used in boiler systems.
52. Describe draft and the basic equipment used to supply combustion air to a boiler furnace.
53. Describe the types of feedwater systems used for boilers.
54. Describe the purpose, equipment, and operation of blow down in boiler systems.
55. Describe the purpose, equipment and operation of fireside cleaning in boiler systems.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 6 of 8**

Part "B"

B1. Lubrication

1. Describe the importance of lubrication and the operating principles of lubrication.
2. Describe the methods for basic care and maintenance of bearings and their related lubrication systems.

B2. Pumps and Compressors

3. Describe the construction and operating principles of various types of pumps used in buildings and industrial plants.
4. Describe maintenance procedures for efficient and reliable pump operation.
5. Describe the construction and operating principles of the different types of compressors.
6. Describe the startup, operation, and shut down of different types of compressors.

B3. Boiler Safety Devices

7. Explain the code and standards requirements, design, and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels.
8. Explain the design and operation of combustion safety controls on burners and boilers.
9. Describe feedwater control methods and devices used on boilers.
10. Describe the code and standards required and operation required fittings, along with the operating principles of fittings found on boilers.
11. Name and describe the operating and safety controls found on boilers.

B4. Plant (Boiler) Operations

12. Describe the safe and efficient operational procedures that relate to starting up the auxiliary equipment in a boiler plant.
13. Describe the safe and efficient operational procedures that relate to starting up boiler systems.
14. Describe the safe and efficient operational procedures that relate to operating boilers.
15. Describe the operational checks that need to be conducted for an operating boiler plant.
16. Describe generic shutdown and layup procedures for different boilers.
17. Describe the essential points and readings that need to be monitored and recorded in a plant.

B5. Power Plant /Heating Plant Maintenance

18. Describe the safe use of common hand tools in the powerhouse.
19. Describe mechanical fasteners and the safe and proper setup of equipment for hoisting and working above ground.
20. Describe the service and maintenance required for boilers.
21. Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical and chemical boiler cleaning methods.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
CERTIFICATE of COMPETENCY
EXAMINATION**

**November 2022
PAGE 7 of 8**

Part "B"

B6. Water Treatment

22. Describe the general principles, methods, and equipment used in preparing raw feedwater for steam production in a boiler.
23. Describe the general principles, methods and equipment used for the internal treatment of boiler water.
24. Discuss the general principles, methods and equipment used for the treatment of condensate.
25. Discuss the general principles, methods and equipment used for the treatment of cooling tower and condenser water.
26. Describe cooling water/chilled water effects, treatment and tests.
27. Describe heating system water effects, treatment and tests.

B7. Prime Movers and Engines

28. Describe the conversion of heat into mechanical energy and the history of steam engine.
29. Describe the construction and operation of steam turbines.
30. Describe the operation and maintenance of cooling towers and condensers.
31. Describe the application, set up operation, and maintenance required for gas turbines.
32. Describe the application, construction, and operation of internal combustion engines.

B8. Auxiliary Building Systems

33. Explain lighting systems and some of the basic design considerations for lighting a space.
34. Explain the various water supply systems used in buildings.
35. Describe the design and components of various sanitary drainage systems used in buildings.

B9. Refrigeration

36. Explain the basic concept of refrigeration and refrigerants.
37. Describe the operating principles, operation, and maintenance of compression refrigeration systems.
38. Describe the purposes and operating principles of the operational and safety controls on a refrigeration system.
39. Describe the operating principle, maintenance and operation of absorption refrigeration systems.

B10. Heating Ventilating and Air Conditioning

40. Explain the methods and techniques for conditioning air for human comfort and health.
41. Explain the equipment and principles of humidification.
42. Describe the air flow behaviour and movement of air through distribution systems.
43. Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems.
44. Describe the designs and components of duct systems used in air conditioning.
45. Describe the various types of coils used in HVAC systems as well as their operation.



**REFERENCE SYLLABUS
For
FOURTH CLASS
POWER ENGINEER'S
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EXAMINATION**

**November 2022
PAGE 8 of 8**

Part “B”

B11. Heating and Cooling Systems

46. Describe the operating principles and maintenance procedures of steam heating systems and the components of these systems.
47. Describe the various designs of hot water heating systems as well as their equipment and operation.
48. Describe the common heating systems that a Power Engineer may encounter.
49. Describe central, unitary, and combined types of HVAC systems.
50. Describe heat gains and losses and the common methods of recovering energy from the system.
51. Describe the control systems strategies used in HVAC systems.

B12. Types of Plants

52. Identify steam-related processes in some common types of plants that employ Power Engineers.