



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: September 2023

Module Number: MN 4307

Module Name: Steam Plants and Gas Turbines

[Three Hours]

[Answer **Five Questions** selecting at least one question from each section.
Each question carries **equal** marks. Clear labelled sketches will be given credits.]

SECTION – A – STEAM BOILERS

- Q1 a) Sketch and describe the operation and construction of an External Superheater 'D' Type I (ESD I) type water tube boiler.
[07 Marks]
- b) As an officer on watch, when the low water level alarm in the boiler frequently activates, assuming the gauge glass is clear and in good working order, what should be the course of action?
[07 Marks]
- c) Why is it important to conduct regular water testing in auxiliary boilers? For each test normally carried out, state;
i. the reasons for maintaining proper water quality in these systems.
ii. acceptable values for any particular type of auxiliary boiler,
iii. action required when measured values differ appreciably from desired values.
[06 marks]
- Q2 a) With reference to Water tube boilers:
i. Explain the necessity in controlling the superheat temperature of steam and methods employed for its control.
ii. State the reasons to install de-super heater and attemperator on a boiler.
iii. Explain with reasons for using extremely low ppm water with water tube boilers.
[06 marks]
- b) Sketch and describe closed feed water system and indicate the direction of flow in all

pipelines.

[06 marks]

c) Sketch and describe a De-aerator installed in a Closed Feed Water System

[04 marks]

d) Sketch and describe a Tubular type water level gauge glass fitted to a boiler.

[04 marks]

SECTION – B – STEAM TURBINES

Q3 a) With reference to impulse turbines draw velocity, pressure and enthalpy characteristics of steam for compounding for velocity and compounding for pressure stages.

[08 marks]

b) Discuss with diagrams the passage of steam through a reaction turbine, explain clearly what happens to the steam as it passes through a stage in the turbine.

[07 Marks]

c) Explain saturated and superheated Rankine cycles.

[05 Marks]

Q4 a) State the type of losses caused with steam turbines.

[05 Marks]

b) A turbine protection system is provided with all installations to prevent damage resulting from an internal turbine fault or the malfunction of some associated equipment.

i. State the arrangements made to shut the turbine down in an emergency.

[03Marks]

ii. Identify the main fault conditions leading to operate this arrangement.

[03 Marks]

c) Explain the difference between condensing and non-condensing type of turbine Systems, giving suitable circuit diagrams.

[05 Marks]

d) Explain the necessity in using extraction and reheating stages in steam turbine configurations operating at multiple pressures.

SECTION – C – GAS TURBINES

- Q5 a) State three different methods of compressor blade attachment. [3 Marks]
- b) State the two methods of minimizing the gap between the compressor blades and housing. Provide a brief explanation of each. [5 Marks]
- c) Provide a detailed explanation of the different methods of blade cooling in the turbine section of a gas turbine. [6 Marks]
- d) Explain your understanding of the term “work done factor” of the compressor section of a gas turbine clearly highlighting the need to incorporate such a factor when calculating the work done by the compressor. [6 Marks]
- Q6 (a) Name the three different zones of a gas turbine combustion system. Provide a detailed explanation of each zone clearly emphasizing their respective functions. [6 Marks]
- (b) “The diffuser of the combustor is essential for the efficient performance of a Gas Turbine”. Do you agree with this statement? Provide a detailed justification for your answer. [6 Marks]
- (c) Provide a comparison between an “annular combustor” and a “tubo-annular combustor” clearly highlighting their differences. [6 Marks]
- (d) Formation of NO_x is a major concern related to the combustion process in a gas turbine. Provide a brief explanation on the formation of NO_x in a gas turbine. State two methods of reducing emission of NO_x from a gas turbine. [2 Marks]