



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 4 Examination in Engineering: November - December 2022

**Module Number: MN 4307**

**Module Name: Steam Plants and Gas Turbines**

**[Three Hours]**

**[Answer Five Questions only, each question carries 20 marks]**

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- Q1 (a) Explain the operation of a Foster Wheeler D type bent tube water tube boiler giving a clearly labeled sketch. [7 Marks]
- (b) With reference to water tube boilers:
- List all type of mountings attached to it and explain their functions.
  - "Water level of a boiler is critical". Explain with reasons. [7 Marks]
- (c) Explain the procedure of the following boiler water tests,
- Chloride
  - Alkalinity phenolphthalein
  - Phosphates
  - Vanado molybdate. [6 Marks]
- Q2 (a) With clear sketches describe an open feed water system, indicating the direction of flow in all pipelines. [8 Marks]
- (b) "Scale forming salts found in boilers are not desirable". Explain the statement with reasons. Describe the impact of Magnetite, Hematite, Copper and Copper oxide formation in boiler water. [4 Marks]
- (c) You are an officer on watch, & finds the boiler water-level gauge glass is empty & the burner firing. What is your course of action? (Assuming the gauge glass to be clear & good working order). [8 Marks]

- Q3 (a) Explain with the aid of diagrams what is meant by
- i. Velocity compounding
  - ii. Pressure compounding in impulse turbine.
- [7 Marks]
- (b) Draw inlet and outlet velocity diagrams for actual simple impulse stage of a steam turbine and derive an equation for the stage efficiency of it.
- [7 Marks]
- (c) 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.
- [6 Marks]
- Q4 (a) With reference to cross compound double reduction steam turbine explain the following,
- i. Operation and construction of it, reasoning the advantage of a built-in astern turbine.
- [6 Marks]
- ii. Lubrication system, reasoning the advantage of a header tank.
- [6 Marks]
- (b) State the necessity of labyrinth packing arrangement in steam turbines
- [4 Marks]
- (c) Explain saturated and superheated Rankine cycles.
- [4 Marks]
- Q5 (a) The absolute velocity of air entering the rotor of a stage of an axial flow compressor makes an angle  $\alpha_1$  with the axial direction. If  $C_{w1}$  is the tangential or "whirl velocity" and  $C_a$  is the axial velocity component, show that,
- $$C_{w1} = C_a \tan(\alpha_1)$$
- Note: Sketch the Velocity Triangle for air entering the rotor and name the relevant velocity components
- [6 Marks]
- (b) "All work absorbed by a compressor stage is due to the change in the tangential or whirl velocity". Do you agree with this statement? Explain your answer.

[4Marks]

- (c) State three (03) methods of blade cooling in the Turbine section of a Gas Turbine engine. Provide a brief explanation of each.

[6 Marks]

- (d) What type of instabilities in operation may occur during the operation of an axial compressor section of a Gas Turbine engine? Explain briefly.

[4 Marks]

- Q6 (a) State the main components and combustion zones of a Gas Turbine combustion system. Indicate each component and combustion zone on a clearly drawn sketch.

[8Marks]

- (b) Describe the importance and functioning of the diffuser section of the combustor.

[4 Marks]

- (c) State the different type of combustors and discuss the main characteristics of each.

[4 Marks]

- (d) Write brief descriptions of the following with respect to the combustor,

i. Combustion stability

[2 Marks]

ii. Fuel injection and atomization

[2 Marks]