



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

**UNIVERSITY EXAMINATION FOR THE DEGREE IN SCIENCE IN RENEWABLE
ENERGY TECHNOLOGY AND MANAGEMENT**

3RD YEAR 2ND SEMESTER 2023/2024 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1310

COURSE TITLE: HYDROPOWER TECHNOLOGY II

EXAM VENUE:

STREAM: BSc. REN ENGY TEC & MGT

DATE: /04/2024

EXAM SESSION:

DURATION: 2 HOURS

Instructions

- 1. Answer question 1 (Compulsory) and ANY other two questions**
- 2. Candidates are advised not to write on question paper**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

QUESTION ONE (30 Marks) (Compulsory)

- a) State and explain the difference between the impulse and reaction turbine. **(5 marks)**
- b) With reference to a layout of a Hydro-Power plant, show the various components describing their functions. **(8 Marks)**
- c) Briefly discuss Euler pump and turbine equations, explaining how they can be used to determine the head developed by a pumped or utilized by a turbine. **(9 Marks)**
- d) Define cavitation and explain various methods of avoiding cavitation. **(4 Marks).**
- e) Explain fully four major challenges that hinder exploitation of hydropower resources in most developing countries. **(4 Marks).**

QUESTION TWO (20 Marks)

- a) Describe four factors governing selection of suitable types of turbine. **(4 Marks).**
- b) Using sketches describe four major parts of a Francis turbine, stating their functions. **(8 Marks).**
- c) Using a diagram explain the working mechanism of a Gas turbine. **(4 Marks)**
- d) Explain in detail the governing action in hydraulic turbines and how it is achieved in both the reaction and impulse turbines. **(4 Marks).**

QUESTION THREE (20 Marks)

- a) How is the water hammer in the penstock of a hydropower plant managed. **(2 Marks).**
- b) With the aid of a sketch describe the principle operation of Pelton turbine. **(5 Marks).**
- c) The jet velocity in a pelton turbine is 65 m/s. The peripheral velocity of the runner is 25 m/s. The jet is deflected by 160° by the bucket. **Determine the power developed and hydraulic efficiency** of the turbine for a flow rate of 0.9 m³/s. The blade friction coefficient is 0.9. **(7 Marks).**
- d) Using a turbine unit sizing diagram describe the optimum operation position for the three commonly used types of turbines. **(6 Marks)**

QUESTION FOUR (20 Marks)

- a) Describe the principle operation of the following turbines
 - i) Archimede's Screw turbine.
 - ii) Turgo turbine.

iii) Cross -flow turbine. **(9 Marks).**

- b) A Francis turbine works under a head of 120 m. The outer diameter and width are 2 m and 0.16 m. The inner diameter and width are 1.2 m and 0.27 m. The flow velocity at inlet is 8.1 m/s. The whirl velocity at outlet is zero. The outlet blade angle is 16° . Assume $\eta_H = 90\%$. Determine, power, speed and blade angle at inlet, and guide blade angle. **(11 Marks).**

QUESTION FIVE (20 Marks)

- a) Explain what is meant by specific speed of a turbine. **(2 Marks)**
- b) At a location, the head available was 50 m. The power estimated is 40,000 kW. The speed chosen is 600 rpm. Determine the specific speed and indicate the suitable type of turbine **(4 Marks)**
- c) Hydropower energy is a renewable energy source, justify this and show link. **(2 Marks)**
- d) Describe the principle operation of the following types of hydropower plants.
- i. Pumbed Storage Hydropower.
 - ii. Run-off Hydropower.
 - iii. Conventional Hydropower. **(6 Marks).**
- e) Explain the principle of operation of the turbines below.
- i. Shrouded Tidal turbine **(3 Marks)**
 - ii. A Well's turbine **(3 Marks)**