



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND
TECHNOLOGY**

SCHOOL OF ENGINEERING AND TECHNOLOGY

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

THIRD YEAR RESIT EXAMINATIONS 2020/21 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TET 3325

COURSE TITLE: HYDROPOWER TECHNOLOGY II

EXAM VENUE: STREAM: BSc REN TECH & MGT

DATE: ../11/2020 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 (Compulsory) (30 Marks)

- a) Justify how hydropower is one of the renewable energy sources. (4Marks)
- b) i) What are velocity triangles? (2 Marks)
 ii) Demonstratively explain (with the help of diagrams), velocity triangles for a Pelton Turbine (4 Marks)
- c) Discuss four types of turbine efficiencies. (4 Marks).
- d) Define cavitation and explain four methods of avoiding cavitation. (6 Marks).
- e) The diagram **Fig Q 2.1** below shows a hydropower systems design.
 - i. Name the hydropower system shown. (2 marks)
 - ii. Name the labels **1, 2, 3** and **4** (4 marks)
 - iii. What is the suitable term that represent the difference between **A** and **B**, as shown in the diagram Fig Q 2.1? (2 marks)

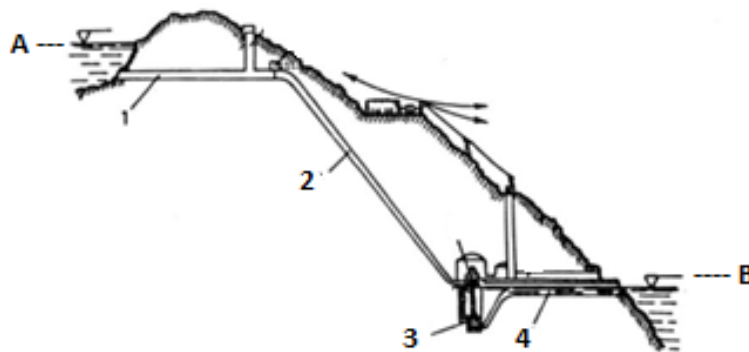


Fig Q 2.1

- f) How is the water hammer in the penstock of a hydropower plant managed? (2marks)

QUESTION TWO (20 Marks)

- a) Describe four factors governing selection of suitable type of turbine. (4 Marks).
- b) Define the following terms: - (4 Marks).
 - i) Penstock
 - ii) Tunnel
- c) Using a diagram explain the working mechanism of a Gas turbine. (4 Marks)
- d) A Francis turbine works under a head of 120 m. The outer diameter and width is 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.

(8Marks)

QUESTION THREE (20 Marks)

- a) The diagrams **Fig Q 3.a** below, shows the problem that results from a poor design consideration.
- Name the cause of the damage that can be seen in the two different runners shown below.
 - How can this problem be solved? (1+2 Marks)

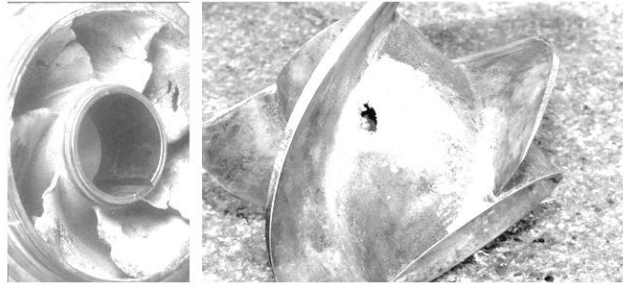


Fig Q 3. a

- b) i) From the sketch **Fig 3. b** below, name the kind of turbine it is. (2marks)
- ii) Name the parts labeled 1, 2,3,4 and 5. (5 marks)

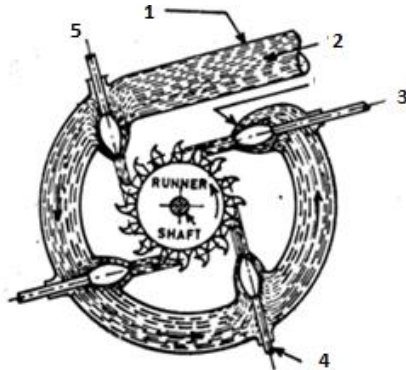


Fig 3.b

- iii) Explain its principle of operation. (4 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 $0.9 \text{ m}^3/\text{s}$. The blade friction coefficient is 0.9. (6 Marks)

QUESTION FOUR (20 Marks)

- a) i) What are the approximate heads ranges for Pelton, Kaplan and Francis (3marks)
- ii) Show expressions for calculating Dimensional and non-dimensional Speed. (4 Marks)
- iii) What are the conditions for maximum efficiency for Pelton turbine? (3 marks)
- b) Explain the function of draft tube in the case of reaction turbines (4 Marks)
- c. A suitable power potential at a remote location along River Yala, was estimated as 4 MW. The head available was 35 m. The speed chosen is 300 rpm.
- Determine the dimensional and non-dimensional specific speeds.
 - If the speed ratio is 0.8 and the flow ratio is 0.35 determine the diameter of the runner.

(6 marks)

QUESTION FIVE (20 Marks)

- a) Explain what is meant by specific speed of a turbine. (2 Marks)
- b) Describe the principle operation of the following types of hydropower plants.
 - i. Pumped Storage Hydropower. (2 marks)
 - ii. Run-off Hydropower. (2marks)
 - iii. Conventional Hydropower. (2 marks)
- c) Considering economic, social and environmental impacts, compare the Hydropower with Thermal Turbines Technologies (6 Marks)
- d) i) The hydropower system designs are divided into two. Name them. (2 Marks)
 - ii) The Fig 5.d. below, represent which type of hydropower design? (2 Marks)
 - iii) What is the name of the turbine in **Fig Q 5.d.** below? (2 Marks)

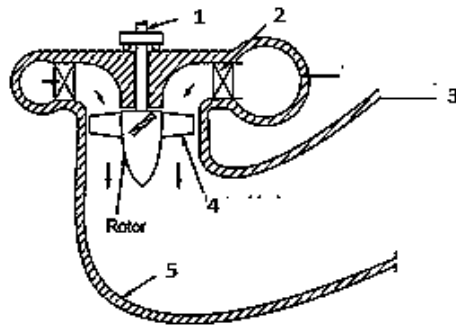


Fig 5.d.