



KIBABII UNIVERSITY

2024/2025 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER

MAIN EXAMINATIONS

**FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND
BIOFUELS TECHNOLOGY**

COURSE CODE: REN 421

COURSE TITLE: Hydropower

DATE: 22/04/25

TIME: 8-10AM

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn Over

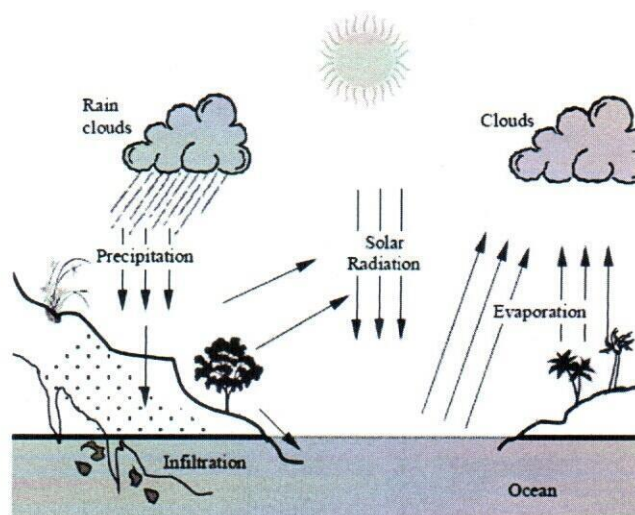


KIBU observes ZERO tolerance to examination cheating

SECTION A: Compulsory (30 Marks)

Question One

(a) The figure below explains the origin of hydropower.



- (i) Name the cycle represented in the figure [1 Marks]
- (ii) Use the figure to explain the origin of hydropower [5 Marks]
- (iii) Explain how human activities can have negative influence on the cycle [5 Marks]
- (b) (i) Explain how tides are caused [2 Marks]
- (ii) With the help of sketches, describe **three** methods of generating power from tides [6 Marks]
- (c) With reference to power generation:
 - (i) State the advantages of run-of-the-river schemes [3 Marks]
 - (ii) State the disadvantages of dammed hydropower schemes [3 Marks]
- (d) Show that power generated from a hydropower is given by [5 Marks]

$$P = \rho gQH$$

Where ρ is the density of water [kg/m^3], g is the gravitational constant [m/s^2], Q is the flow rate of water [m^3/s] and H corresponds to the head height [m].

SECTION B: Answer ANY TWO QUESTIONS (40 Marks)

Question Two

A certain coastal Municipality wants to install a hydropower to provide electricity. A stream of treated wastewater runs down a hill to a shoreline where it is possible to construct a simple hydropower scheme. The effective head (H) is 25.0 meters and water flows (Q)

through the system at a rate of $0.50 \text{ m}^3 / \text{sec}$. The simple inexpensive hydropower scheme has a working efficiency of 85%.

- (i) Determine power that can be generated with this system per year [7 marks]
- (ii) Find how many houses this energy can support, assuming an average community consumption of 12,000 kWh per year per house [3 marks]
- (iii) How much Oil would be required in an Oil-fired power plant to generate the equivalent amount of electrical energy as the hydropower generates in a year? The energy content of Oil is 11,630 kWh/ton. [5 marks]
- (iv) How much CO_2 emissions would be if the Oil power plant was used? The Oil power plant produces 0.27 kg CO_2 per kWh. [5 marks]

Question Three

Sketch a typical run-of-the-river power scheme and explain all the components [20 marks]

Question Four

- (a) Explain the purpose of the weir at the intake [3 Marks]
- (b) (i) Describe the purpose of the channel [2 Marks]
- (ii) Explain why the slope of the canal is kept as low as possible [4 Marks]
- (c) Explain the purpose of the spillways in canals [4 Marks]
- (d) (i) Briefly describe the common penstock materials [7 Marks]

Question Five

- (a) (i) List at least three hydro-electric turbines, and [3 Marks]
- (ii) Describe each of the turbines listed in (a) (i) [12 Marks]
- (iii) Indicate the typical operational range of each turbine listed in (a) (i) [3 Marks]
- (b) State any three materials used to manufacture penstocks [2 Marks]