Graphic Era
HILL UNIVERSITY
Established by an Act of the State Legislature of Uttarakhand (Admissible Section 12 of 2011)
University under section 2(f) of UGC Act, 1956

End Term (Even) Semester Examination May-June 2025

Roll no.....

Name of the Program and semester: B. Tech (Civil Engineering), IV Semester
Name of the Course: Hydraulics and Hydraulic Machines
Course Code: TCE 401

Time: 3-hour

Maximum Marks: 100

Note:

(i) All the questions are compulsory.
(ii) Answer any two sub questions from a, b and c in each main question.
(iii) Total marks for each question is 20 (twenty).
(iv) Each sub-question carries 10 marks.

Q1 **(2x10 = 20 marks)**

(a) State Buckingham's π theorem and explain procedure for determining the π-groups and their functional relationship.

(b) Define the following geometrical parameters of an open channel with sketches:
(a) Flow depth
(b) Wetted perimeter
(c) Hydraulic radius
(d) Top width **CO1**

(c) A trapezoidal channel has side slopes of 1H:1V, bottom width 3 m, and depth of flow 1.5 m. Calculate the hydraulic radius.

Q2 **(2x10 = 20 marks)**

(a) Explain the difference between gradually varied flow and rapidly varied flow. Give two examples for each.

(b) Determine the length of a GVF profile (M1) in a rectangular channel of width 4 m carrying 12 m^3/s of flow, with a bed slope of 1 in 3000. The initial depth is 2.4 m, and the final depth is 1.9 m. Use Manning's n = 0.015 and step method with a single step of 0.5 m. **CO2**

(c) A 3 m wide rectangular channel has a flow depth of 0.5 m and flow rate of 5 m^3/s. Calculate the critical depth and check whether the flow is subcritical or supercritical.

Q3 **(2x10 = 20 marks)**

(a) What is boundary layer separation? Explain the causes, effects, and methods of controlling boundary layer separation.

(b) A thin plate 0.5 m long and 0.3 m wide is moving in air at a velocity of 4 m/s. Calculate the Reynolds number at the trailing edge. Assume air properties:
$\nu = 1.5 \times 10^{-5}$ m^2/sec. **CO3**

(c) Explain the concept of boundary layer. Write short notes on various thicknesses of boundary layer.

(2x10 = 20 marks)

Q4

(a) A centrifugal pump has an impeller diameter of 0.4 m and runs at 1440 rpm. Calculate the minimum starting speed if it is 30% of the full speed.

(b) Derive the formula for the force exerted by a jet on a fixed flat vane when the jet strikes normally and when it strikes at an angle. CO4

(c) Write a note on cavitation phenomena in a pump.

Q5 (2x10 = 20 marks)

(a) A Pelton wheel has buckets rotating at 12 m/s. Water jets strike the buckets with velocity 30 m/s. If the flow rate is 0.1 m^3/s, calculate the power developed by the turbine and the hydraulic efficiency if the output power is 25 kW. Define and explain hydraulic efficiency, mechanical efficiency and overall efficiency of a turbine.

(b) Illustrate the various types of draft tubes with neat sketches and describe their purposes in turbine operation. CO5

(c) Define the following terms related to turbines:

- Hydraulic efficiency
- Mechanical efficiency
- Overall efficiency