Library.

00030

CINEC CAMPUS
Beyond A Graduate

Colombo International Nautical & Engineering College
Faculty of Engineering & Technology
Bachelor of Science Honours in Engineering

CE3323: Advanced Hydraulics Design and Modelling

Final Examination – First Attempt (Semester-3)

(70% of Component 2 weighting)

Date : 20th June 2025

Examiner : Nimali Sugandika

Time Allowed : 3 Hours

INSTRUCTIONS TO CANDIDATES

- This question paper consists of **five** Questions.
- Answer **only four** questions
- Show **all stages** of your work
- You should write legibly in black or blue ink.
- This is a closed book examination

MATERIALS REQURIED

- Answer booklet.
- You may use a scientific calculator. This must not be programmable, and may be inspected during the examination. Programmable calculators, PDAs and mobile phones are not permitted in the exam.

Q1.

(a) What are the units and dimensions of the following quantities, **[25%]**

(i) Shear Stress

(ii) Kinematic viscosity

(iii) Manning's n

(iv) Hydraulic radius

(v) Pressure

(b) Describe what is meant by dimensional homogeneity. **[15%]**

(c) The discharge through a small orifice (Q), depends upon the area of the orifice (A), the head above the orifice (H), and gravity (g). Derive the discharge equation using both the Rayleigh and Buckingham π methods, and show that the same equation can be obtained in both cases. **[60%]**

Q2.

(a) Describe what is meant by similarity? **[20%]**

(b) If two pumps are said to be similar, what does this mean? **[20%]**

(c) Pumps A and B are similar and can be related by $\left[\frac{Q}{ND^3}\right]_A = \left[\frac{Q}{ND^3}\right]_B$.

Pump A has an impeller diameter of 0.4m and runs at a speed of 1400rpm. If pump B has a diameter of 0.8m, what speed would it have to run at to achieve the same discharge? **[30%]**

(d) If pump B in part (c) also ran at 1400rpm, what would be its discharge compared to pump A? **[30%]**

Q3.

(a) The discharge per meter length of weir crest (q) is thought to depend upon the head (H) over the crest, the height of the crest above the river bed (p) and gravity (g). Find the form of the equation using both the Rayleigh and Buckingham π methods. Is ρ significant? **[70%]**

(b) If a broad crested weir has a coefficient of discharge (C) of 1.65, and it is completely spans a 17.4m wide rectangular channel, what would be the head over the weir when the crest above the river bed (p) is 0.2m and the discharge is 6.8 m^3/s. **[30%]**

Q4.

(a) List two ways in which stratification can impact the transport of pollutants in a river-ocean system. **[20%]**

(b) Discuss the effects of thermal and salinity stratification on estuarine circulation and how these factors influence the design of hydraulic structures such as weirs and outfalls. **[40%]**

(c) Describe how thermal stratification can impact the oxygen availability in a freshwater lake and its effect on fish populations. **[20%]**

(d) Evaluate how climate change may intensify stratification in aquatic systems and the potential long-term impacts on fish migration, habitat range, and food availability. **[40%]**

Q5.

An underflow vertical sluice gate discharge freely 56 m^3/s into a rectangular channel 7 m wide (Figure 1). The gate, which is the same width as the channel, is set at a height of 1.4 m above the bed and the depth at the vena contracta (C_cY_G) is 0.85 m. The energy loss in the converging flow at a sluice gate is quite small, so take the head loss between sections 1 and 2 as $0.05V_2^2/2g$. The normal depth in the downstream channel D_N=2.6 m.

(a) Calculate the depth upstream of the gate. **[20%]**

(b) Confirm that the gate is able to discharge freely without submerging. Does a hydraulic jump occurs downstream of the gate and, if so, where? **[30%]**

(c) Use the momentum equation to calculate the force on the gate. (assume the energy coefficients such as α_1 and α_2 , and the momentum coefficient β, are 1). **[50%]**

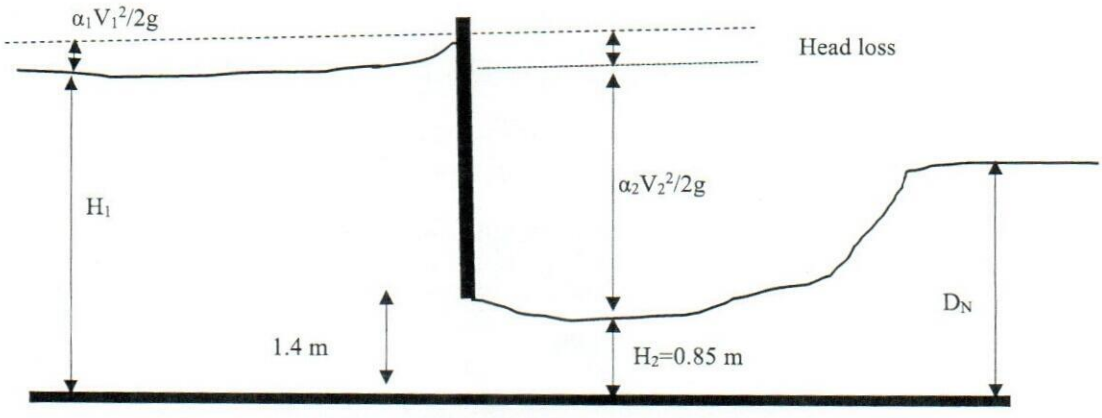

Figure 1

Equations

$$Q = CA\sqrt{2gH}$$

$$D_C = \sqrt[3]{\frac{Q^2}{gB^2}}$$

$$D_3 = \frac{D_2\left(\sqrt{1+8F_2^2}-1\right)}{2}$$