National Exams December 2017

04-Agric-A4, Fluid Flow

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Four (4) questions constitute a complete exam paper.
   The first four questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. All questions require calculation.

Problem 1 (25 points)

Three cast-iron pipes (ε=**0.26**) are laid in parallel with these dimensions:

Pipe 1: L_1 = 800 m d_1 = 12 cm
Pipe 2: L_2 = 600 m d_2 = 8 cm
Pipe 3: L_3 = 900 m d_3 = 10 cm

The total flow rate is **200 m^3/h** of water at 20°C (ρ=**998 kg/m^3**, μ=**0.001 kg/m.s**). Determine
(a) the flow rate in each pipe;
(b) the pressure drop across the system.

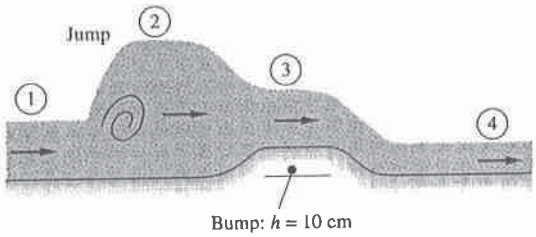
Hint: start by guessing that f_1=f_2=f_3

Problem 2 (25 points)

A small submersible moves at velocity V in 20°C water (**P_v=2.337kPa, density=998 kg/m^3**) at 2-m depth, where ambient pressure is **131 kPa**. Its critical cavitation number is **Ca ≈ 0.25**. At what velocity will cavitation bubbles form? Will the body cavitate if V = 30 m/s and the water is cold (**5°C, Pv=863 Pa, density=1000 kg/m^3**)?

Problem 3 (25 points)

A 10-cm-high bump in a wide horizontal channel creates a hydraulic jump just upstream and the flow pattern as shown in the figure below. Neglect losses except in the jump. If $\mathbf{y_3 = 30\ cm}$, estimate (a) $\mathbf{V_4}$; (b) y_4; (c) $\mathbf{V_1}$; and (d) y_1.(Hint: Assume 3 is critical)



Problem 4 (25 points)

When the pump in the below figure draws **220 m^3/hr** of water at 20°C (density=**998 kg/m^3**) from the reservoir, the total friction head loss is **5m**. The flow discharges through a nozzle to the atmosphere. Estimate the pump power in kW delivered to the water.