

National Exams December 2019

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)

Air under standard conditions ($\rho=1.23 \text{ kg/m}^3$, $\mu=1.79 \times 10^{-3} \text{ N}\cdot\text{s/m}^2$) flows through a **4.0-mm diameter** drawn tubing with an average velocity of $V=50 \text{ m/s}$. For such conditions the flow would normally be turbulent. However, if precautions are taken to eliminate disturbances to the flow (the entrance to the tube is very smooth, the air is dust free, the tube does not vibrate, etc.), it may be possible to maintain laminar flow.

Determine the pressure drop in a **0.1-m** section of the tube if the flow is laminar.

Problem 2 (25 points)

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

Problem 3 (25 points)

Water at 20°C ($\rho = 998 \text{ kg/m}^3$ and $\mu = 0.001 \text{ kg/m-s}$) flows in a 30-cm-wide rectangular channel at a depth of 10 cm and a flow rate of 80,000 cm³/s. Estimate (a) the Froude number; and (b) the Reynolds number.

Problem 4 (25 points)

When the pump in the below figure draws **220 m³/hr** of water at 20°C (density=**998 kg/m³**) 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.

