FREDERICK UNIVERSITY CYPRUS

Department of Mechanical Engineering

SUBJECT: AMEE 202 - FLUID MECHANICS I **DATE: 21 April 2010**
TIME: 1.5 Hours

INSTRUCTIONS TO SUPERVISORS
Students are allowed to use simple calculators.

INSTRUCTIONS TO CANDIDATES:
Answer **all** questions from Section A and **one** question from Section B.
All necessary work must be shown. Wherever needed:
$\rho_{H_2O} = 1000$ kg/m^3, $\mu_{H_2O} = 1.15 \times 10^{-3}$ Pa·s, $\rho_{air} = 1.225$ kg/m^3, $\mu_{air} = 1.79 \times 10^{-5} kg/(m \cdot s)$
g=9.81 m/s^2, $p_{atm} = 1.01 \times 10^5$ N/m^2, 1.0 in= 0.0254 m, 1 ft=12 in

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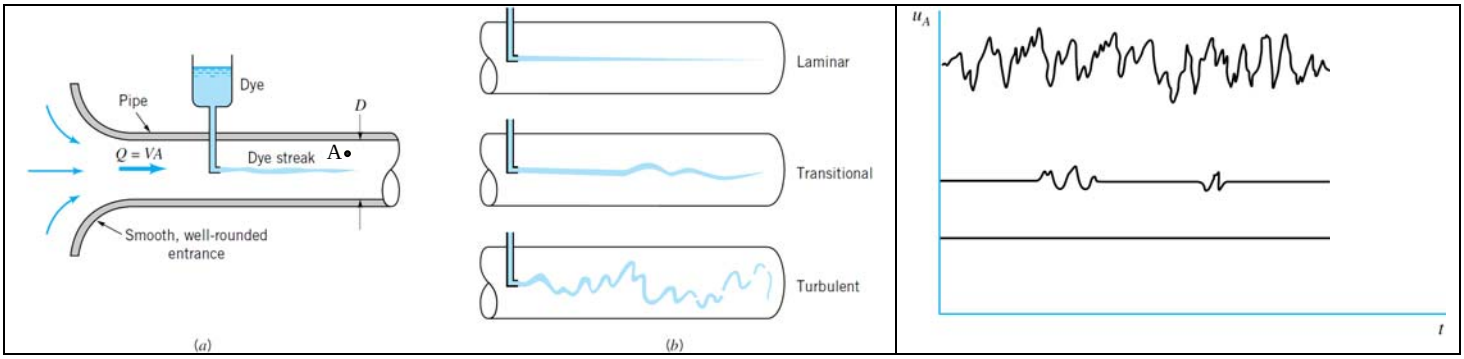
SECTION A

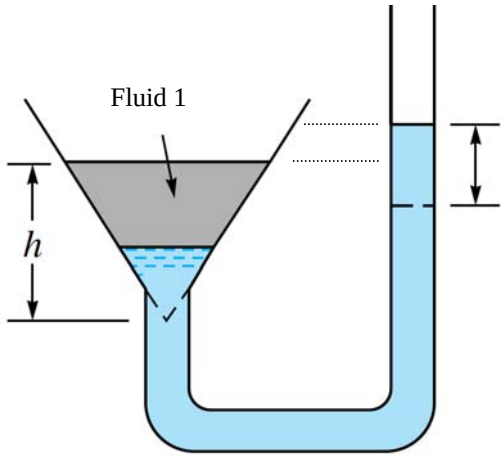
QUESTION 1 [10 Marks]

The flow of a fluid in a pipe may be visualized by injecting neutrally buoyant dye, as shown in Figure (a). For different flow rates different patterns are observed as shown in Figure (b). The time dependence of the fluid velocity at a point (A) is shown on the right Figure. Try and match the shown velocity with a flow pattern, and comment on the nature of the flow.



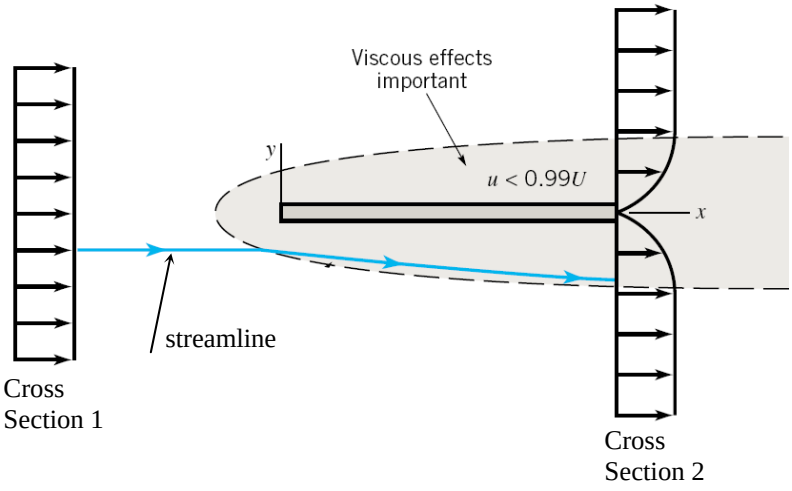
QUESTION 2 [10 Marks]

The U-tube, shown in the figure below, contains two different liquids. Is the configuration shown on the Figure possible? Explain.



QUESTION 3 [15 Marks]

The figure shows the character of viscous flow over a flat plate.

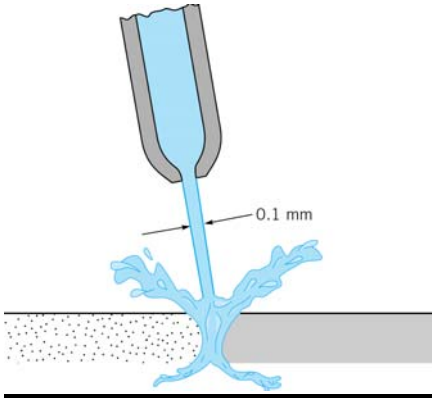


Answer the following questions:

a. Is the velocity profile at section 1 uniform. Explain.
b. Is the velocity profile at section 2 uniform. Explain.
c. Do you expect that the average velocity at section 1 to be higher, equal or smaller than section 2. Explain.

QUESTION 4 [20 Marks]

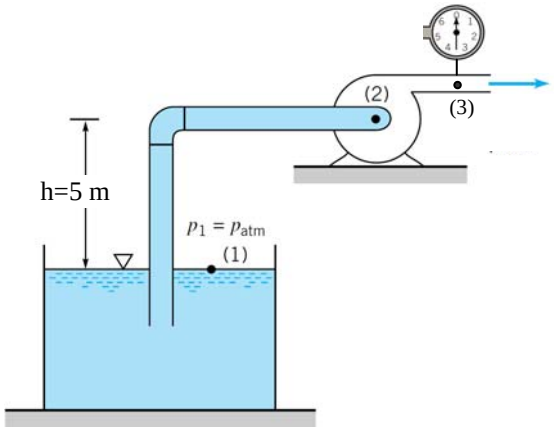
Small-diameter, high-pressure liquid jets can be used to cut various materials as shown in the Figure. If viscous effects are negligible, estimate the pressure needed to produce a $0.1-\text{mm}$-diameter water jet with a speed of $700\ \text{m/s}$. Determine the flowrate.



QUESTION 5 [25 Marks]

The flow-rate through the pump shown on the Figure is $Q = 0.1\ \text{m}^3/\text{s}$. The manometer reading at the pump outlet is $p_{manometer} = 185\ \text{kPa}$, and the diameter of the exit-pipe, at the location of the manometer, is $6\ \text{in}$.

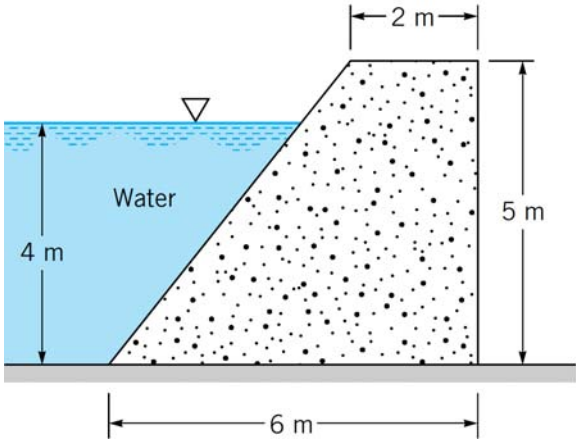
a. Determine the difference in the stagnation pressure between point 2 (pump inlet) and point 3 (pump outlet). Neglect any hydrostatic pressure variation inside the pump. (Hint: To determine the stagnation pressure at point 2 use a streamline between point 1 and point 2).
b. Comment on the difference.



SECTION B

QUESTION 6 [20 Marks]

Assume that the concrete dam shown in the Figure weighs $236\ \mathrm{kN}$ and rests on a solid foundation. Determine the minimum coefficient of friction between the dam and the foundation required to keep the dam from sliding at the water depth shown. The length of the dam is $10\ \mathrm{m}$. To calculate the hydrostatic pressure force F_R, use that the average pressure is the pressure acting at the mid-depth.



QUESTION 7 [20 Marks]

An irregularly-shaped piece of a solid material weighs $35.8\ \mathrm{N}$ in vacuum and $23.4\ \mathrm{N}$ when completely submerged in water. Determine the density of the material.