國立臺灣大學 104 學年度碩士班招生考試試題

Problem 1. (25%) The inviscid air flow coming out from a pipe onto a wall (see Fig. 1) can be described by the potential

$$\phi(x,y) = x^2 - y^2$$

(a) (5%) Is this flow field irrotational?

(b) (5%) Find the stream function $\psi(x,y)$ and velocity field (u,v).

(c) (5%) Draw the streamlines of the flow. (At least 3 important stream lines)

(d) (5%) Find the position $(x_{\max}, y_{\max})$ of the point of maximum pressure.

(e) (5%) Find the complete pressure field $p(x,y)$ if the pressure at origin $p(0,0)$ is set equal to zero.

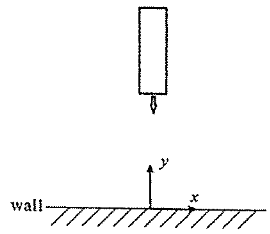

Fig. 1 air jet flowing towards a wall

Problem 2. (25%)

A bridge is to be built on a wide river. The diameter of the cylindrical piers is 1m. The distance between the centers of adjacent piers is 10m. The river width is 500m and flow depth is 10m. The flow velocity is 1.0m/s. Now we use a length ratio 100 to build a model in laboratory. In the laboratory experiment, we consider only one pier; the setup is depicted in Fig. 2. The fluid used is mercury ($\rho_{mercury}/\rho_{water}$=13.6, and $\nu_{mercury}/\nu_{water}$=2). The measured impact force on the pier in lab is 5NT for the whole model pier.

(a) (5%) List all the variables involved in this physical phenomenon.

(b) (5%) Find all the dimensionless parameters (List the process

(c) (5%) What is the flow velocity in the experiment?

(d) (5%) What is the impact force for the real pier?

(e)(5%) Is there any difference if the region of consideration is twice as large, that is to say, we consider two piers and the region has a width of 20m. Explain the reason for your answer. No explanation, no points.

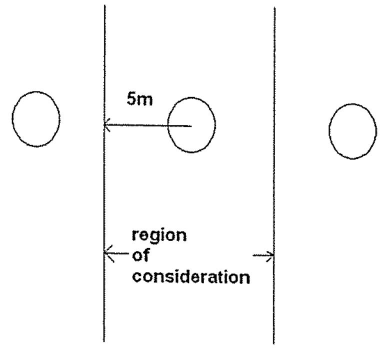

Fig. 2

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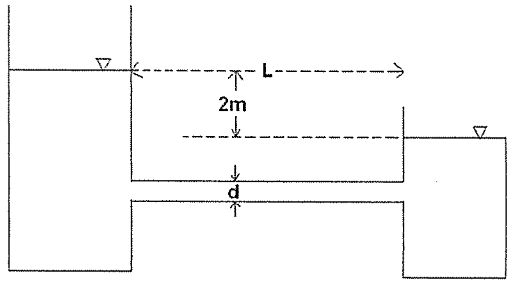
Problem 3. Use the following Moody diagram for this problem. (You should know the details of it) Water flows from left reservoir to right through a long circular pipe. For pipe diameter d = 50cm and pipe length L = 100 m, pipe roughness $\varepsilon = 2$ mm, calculate the flow rate and them draw the energy line and hydraulic grade line. Both reservoirs are considered very large and very wide. Neglect all connection energy loss (25%)



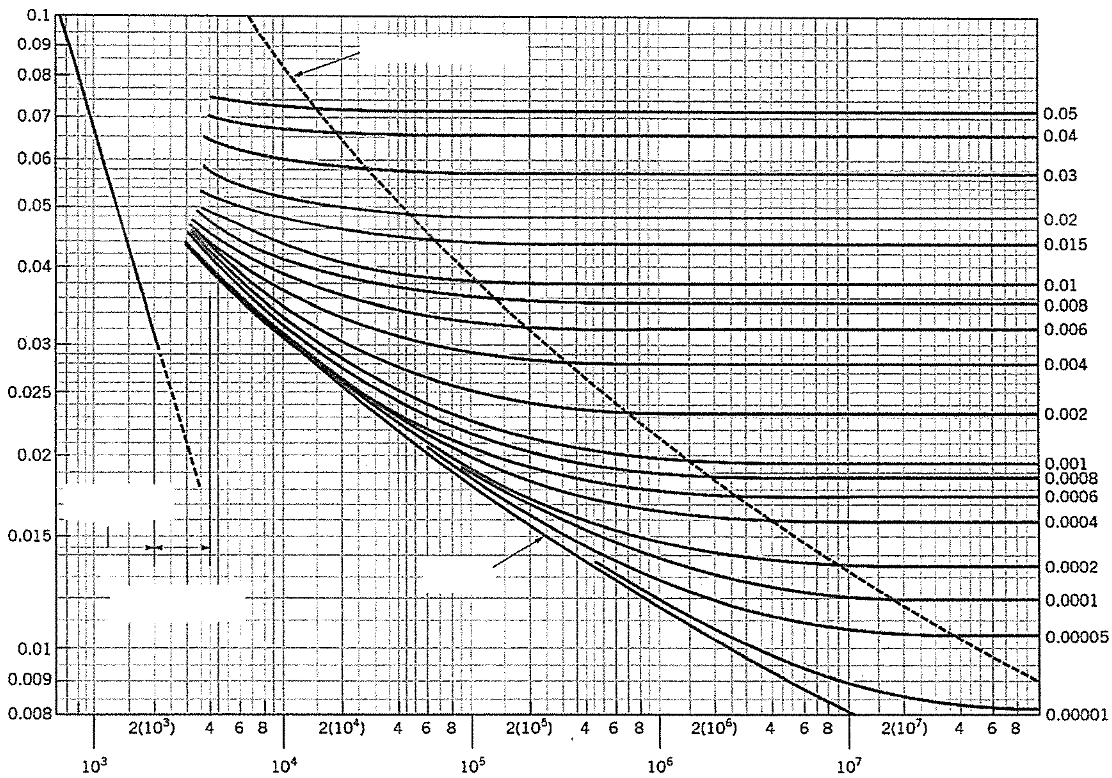


Fig. 3. Blind Moody diagram. All words are erased intentionally.

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Problem 4. As in Fig.4. Water jet impact on the cart, cart starts to move. The jet cross sectional area A_j=20cm^2, the flow rate is 0.2cms. Draw the control volumes for all the questions below.

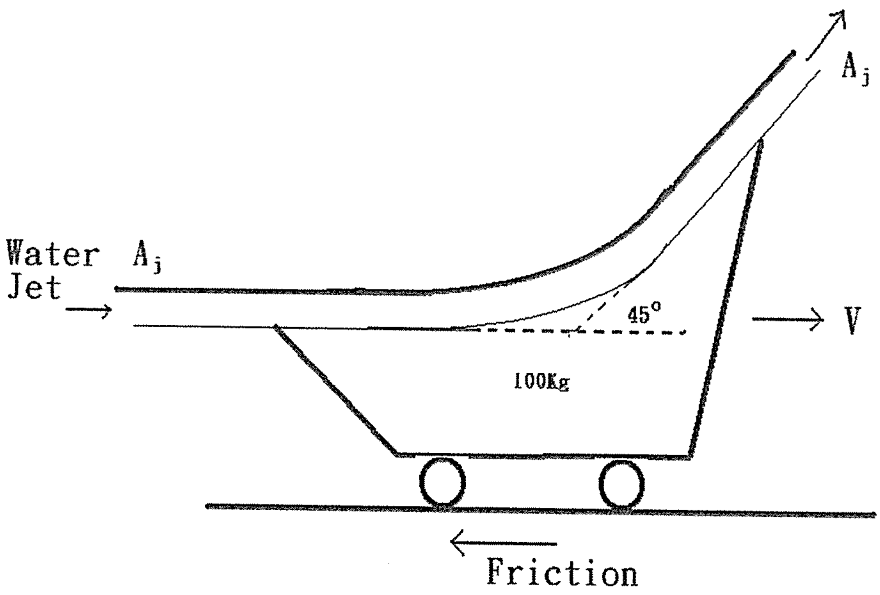
Draw your control volume with fixed and moving control volume --- 2 cases.

With one of the control volume, calculate (a)

(a) (15%) If there is no bottom friction between cart and ground, at the steady state, what is the speed of the cart and what is the force exerted to the cart by water jet?

(b) (5%) With another control volume (for example, if you use moving control volume in (a), then you should use fixed control volume here), redo (a)

(c) (5%) If the friction is 20NT, what is the speed of the cart at steady state. (any control volume is acceptable)



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