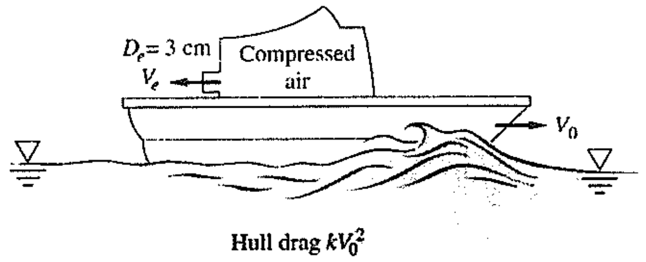
1. (25%) A small boat is driven at a steady speed V_0 by a jet of compressed air issuing from a 3-cm-diameter hole at V_e = 343 m/s. Jet exit conditions are $p_e = 1$ atm and $T_e = 30°C$, where the air density is $\rho_e = 1.165 kg/m^3$. Air drag is negligible, and the hull drag is kV_0^2, where $k \approx 19\ N{\cdot}s^2/m^2$. Estimate the boat speed V_0 in m/s.

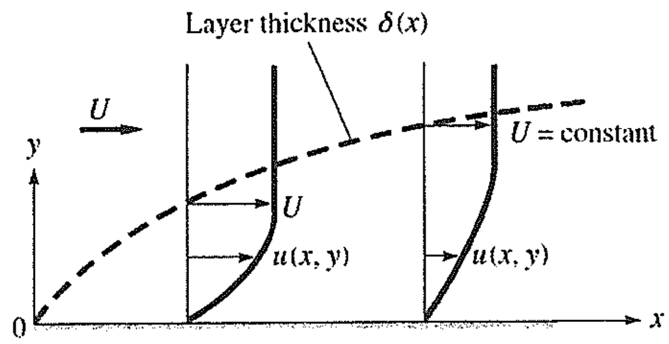


2. (25%) An excellent approximation for the two-dimensional incompressible laminar boundary layer on the flat surface is

$$u \approx U\left(2\frac{y}{\delta} - 2\frac{y^3}{\delta^3} + \frac{y^4}{\delta^4}\right) \quad \text{for } y \le \delta$$

where $\delta = Cx^{1/2}$, C = const

(a) Assuming a no-slip condition at the wall, find an expression for the vertical velocity component $v(x,y)$ for $y \le \delta$. (15%)
(b) Then find the maximum value of v in cm/s at the station $x = 1$ m, for the particular case of airflow, when $U = 3$ m/s and $\delta = 1.1$ cm. (10%)
Hint: find $\partial v / \partial y$ from the continuity equation and then integrate it with respect to y to obtain v



見背面

國立臺灣大學 107 學年度碩士班招生考試試題

科目：流體力學(A)

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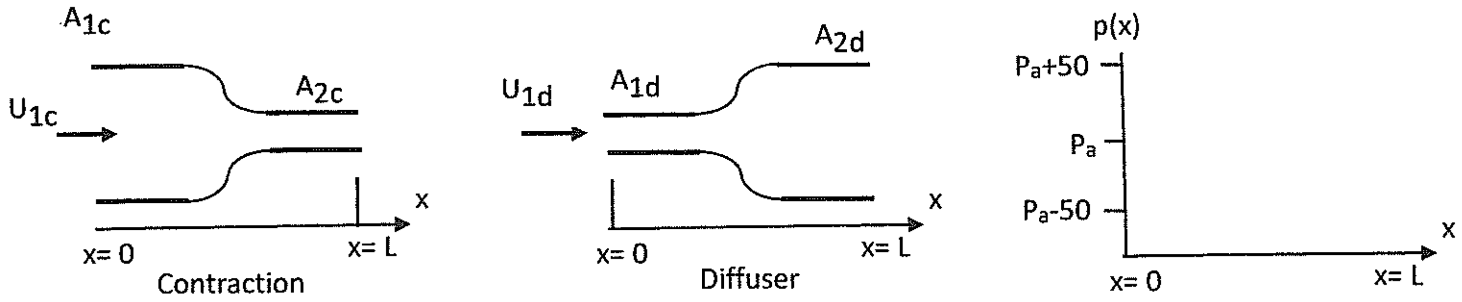
3. (30%) The figure below shows incompressible air flowing through two-dimensional contraction and diffuser, both with length L, with uniform inlet velocity $U_{1c} = U_{1d} = 2$ m/s and areas A_{1c}, A_{2c}, A_{1d} and A_{2d} ,where $A_{1c} = 4\ A_{2c}$ and $A_{1d} = (1/4)\ A_{2d}$. The flow exits to the atmosphere with pressure Pa for both devices. The density of air is approximate 1 kg/m^3. You may use reasonable assumptions and but must justify them clearly.



a) If the flow is <u>viscous</u>, sketch the velocity field at the inlet, outlet and the middle section for the **contraction**?

b) If the flow is <u>viscous</u>, sketch the velocity field at the inlet, outlet and the middle section for the **diffuser**?

<u>**Calculate** and **plot** the following 4 pressure distributions, part c) to f), all on ONE plot using graph template above. (Be sure you label each line clearly).</u>

c) If the flow is <u>inviscid</u>, plot the pressure distribution p(x) along the <u>centerline</u> of the **contraction**.

d) If the flow is <u>inviscid</u>, plot the pressure distribution p(x) along the <u>centerline</u> of the **diffuser**.

e) If the flow is <u>viscous</u>, plot the pressure distribution p(x) along the <u>centerline</u> of the **contraction**.

f) If the flow is <u>viscous</u>, plot the pressure distribution p(x) along the <u>centerline</u> of the **diffuser**.

4. (20%) Consider a steady wind with uniform velocity U over tall building with height H and length and width L, as shown below.

a) Sketch the velocity field around the building (front, side and behind) for both the side view and top view. (6%)

b) Calculate the force due to the wind acting on the building? (6%)

c) If the upstream flow U is not uniform but various with height, U(y), with consideration of a thick boundary layer (i.e. the thickness of the boundary layer is not small compared to H), discuss the effect on the velocity field and the wind load on the building. (8%)

試題隨卷繳回