國立交通大學 107 學年度第 2 學期
博士班資格考筆試考試試題

土木工程學系 水利組　　科目：**渠道水力學**　　選考學生數：2　　考試時間：60 min

1. Drop structures are commonly established to protect piers of bridges from toe scouring in open channels as shown in Fig. 1. State the hydraulics for drop structures. **(15%)** How do you modify the drop structure like fig. 1 considering ecological engineering? **(10%)**

Fig. 1 Drop structures of Zhongzheng Bridge over the Touchien river, Hsinchu

2. The flow over a steep spillway like Fig. 2 commonly produces a supercritical flow and then a subcritical flow downstream. It is only in supercritical flows that hydraulic jumps (bores) can occur. Express the dynamics of the hydraulic jump. **(25%)**

Fig. 2 A photo of hydraulic jump

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3. A 10-m wide, rectangular, concrete-lined canal (n =0.013) has a bottom slope of 0.01 and a constant-level lake at the upstream end. The water level in the lake is 6.0 m above the bottom of the canal at the entrance. If the entrance losses and approach velocity in the lake are negligible, please answer the following questions: (1) Sketch the water surface profile and mark the label of the profile **(10 %)**; (2) use the direct-step method to find the distance from the lake where the flow depth is 3.0 m. **(15 %)**

4. Please (1) draw a specific energy diagram for a given unit discharge in a rectangular cross section having uniform velocity distribution and use the specific energy diagram to describe the alternate depths; **(15 %)** (2) draw specific energy curves for different unit discharges. **(10 %)**

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土木工程學系 水利組　　科目：工程數學　　選考學生數：2　　考試時間：60 min

1. Operational properties of the Laplace Transform.

(a) Proof the theorem: Laplace transform of a derivative.

$L\{f'(t)\} = sF(s) - f(0)$

Let $f(t)$ be continuous on $0 \le t < \infty$, and let $f'(t)$ be piecewise continuous on every finite interval contained in $t \ge 0$, then if $L\{f(t)\} = F(s)$ **(20%)**

(b) Using the Laplace transformation solve the initial value problem $y'' + 3y' + 2y = \sin 2t$, where $y(0) = 2$ and $y'(0) = -1$. **(30%)**

2. Find the particular solution of of $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 4e^{-x} + 5\sin x$, where $y = f(x)$ using the method of undetermined coefficients. **(50%)**

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土木工程學系 水利組　科目：**流體力學**　選考學生數：2　考試時間：60 min

1. Fig.1 is for the problem 1. An expression for the pressure drop per meter is given as

$$\Delta p_l = \frac{\Delta p}{l} = f(V, D, \mu, \rho)$$

(1) Show the dimension of each variable. **(5%)**

(2) Choose three basic variables, ρ, V, and D, to form two π-groups. **(10%)**

(3) For the fluid is water with ρ=1000kg/m^3, μ=1.12×10^{-3}Ns/m^2 and D=1.25cm four experimental results are shown as below. Plot the results in the blank figure, Fig.1, and find the possible fault results. **(10%)**

Case	1	2	3	4
V(m/s)	0.60	1.78	5.20	8.83
Δp_l (**kPa/m**)	0.76	5.00	32.7	63.6

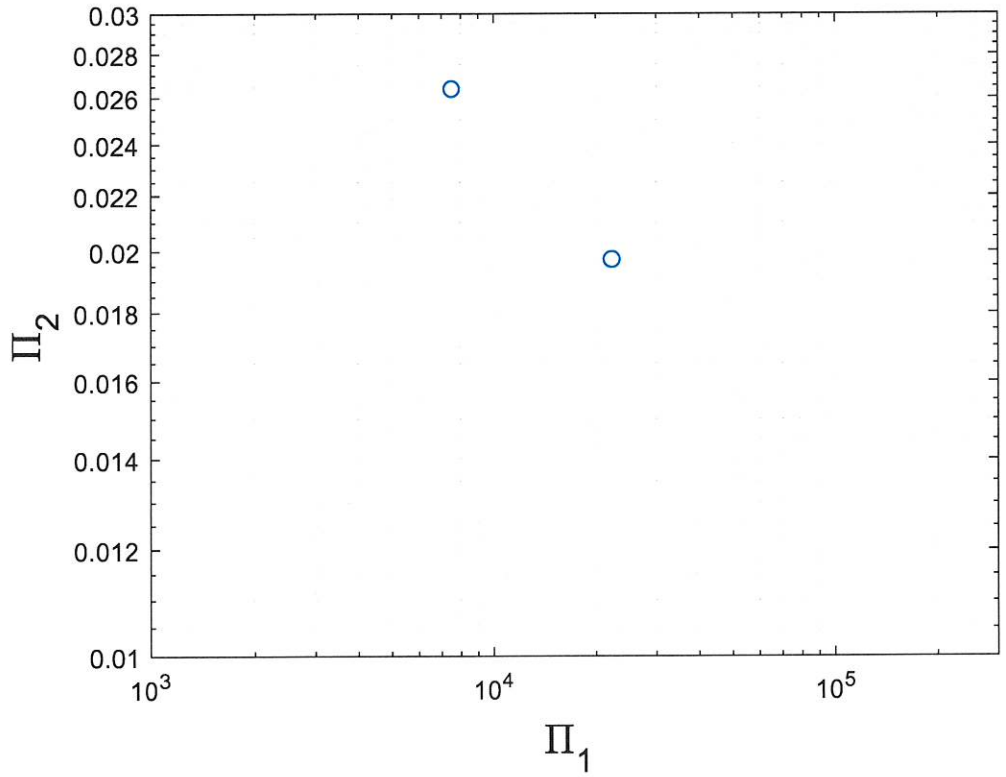


Fig.1Blank figure in a Log scale for the problem 1 (the open circles are **the results for the first two cases**)

NOTE: Plot the results of the last two cases to determine which case is the possible fault result.

2. Fig.2 is for the problem 2. What are the definitions of energy grade line (EGL) and hydraulic grade line (HGL). **(8%)** Explain steeper EGL and HGL at the small pipe than that at the large pipe and a large drop of HGL at the contracted joint. **(7%)**

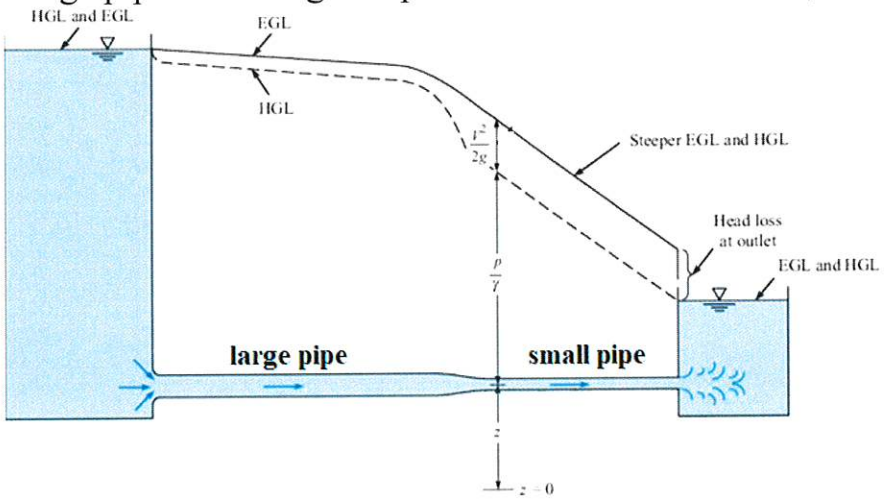
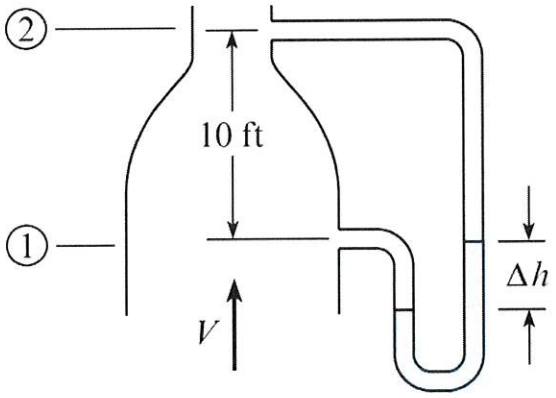


Fig. 3 for the problem 2

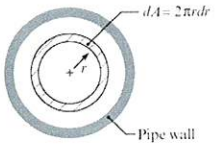
3. Fig.3 is for the problem 3. Air with a density of 0.0644 lbm/ft^3 is flowing upward in the vertical duct, as shown. The velocity at the inlet (section 1) is 66 ft/s, and the area ratio between sections 1 and 2 is 0.43 (A_2/A_1 = 0.43). Two pressure taps, 10 ft apart, are connected to a manometer, as shown. The specific weight of the manometer liquid is 139 lbf/ft^3. Find the deflection, Δh, of the manometer. **(30%)**



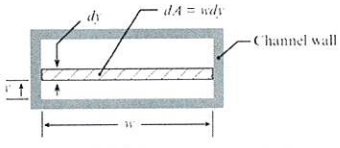
4. Fill in the blanks.

(a) V_{mean} = _____ V_{max}; Laminar flow in a round pipe, V_{max} is the value of the maximum velocity; V_{mean} is an area-weighted average velocity. R is radius of pipe. **(10%)**

$$v(r) = \left(1 - \frac{r^2}{R^2}\right) v_{max}$$



(b) V_{mean} = _____ V_{max}; Laminar flow in a rectangular channel. h is water depth of channel. **(10%)**



$$v(y) = \left(\frac{2y}{h} - \frac{y^2}{h^2}\right) v_{max}$$