國立交通大學 101 學年度第 1 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：1　　考試時間：60 min

1. A sluice gate is shown in Fig. 1. Determine the depth just downstream of the jump (point **b**) if the depth of flow at point **a** is 0.05m and the velocity at point a is 6 m/s. (25%)

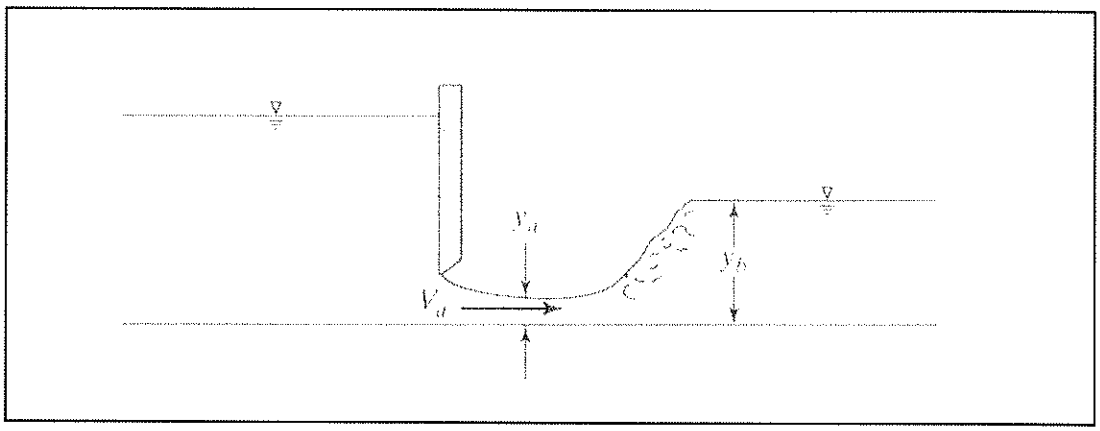

Fig. 1

2. A rectangular channel with n=0.012 is 5 ft wide and is built on a slope of 0.0006 ft/ft. At point **a**, the flow rate is 60 cfs and y_a =3 ft. Using one reach and assuming the head loss can be estimated by Manning's formula, find the distance to point **b** where y_b=2.5ft. (25%)

3. A channel of rectangular cross section 10ft in width carries 300 cfs of water at a normal depth of 5 ft. Estimate the change in upstream depth which would result from the installation of a centrally located pier 3 ft wide and 6 ft long with well-rounded leading edge. (50%)

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土木工程學系 水利組　科目：工程數學　選考學生數：1　考試時間：60 min

1. Solve the following initial value problem:(25%)

$$2xy\frac{dy}{dx}=3y^2+x^2,\quad y(1)=2$$

2. Solve $\begin{cases} x''=3x'-y'-2x+y \\ x'+y'=2x-y \end{cases}$, $x(0)=0, x'(0)=0, y(0)=-1$, (by taking the Laplace transform. (25%)

3. Consider a two-dimensional flow having the velocity $\mathbf{v}(t)=x(t)\mathbf{i}-y(t)\mathbf{j}$

   (1) Express the position vector $\mathbf{r}(t)$ of the individual particles of the flow. (Hint: $\mathbf{v}(t)=\frac{d\mathbf{r}}{dt}$) (10%)

   (2) Find the position of the particle at time t=2 and t=3 that was initially at (1,1) at time t=0. (5%)

   (3) Is the flow compressible? (5%)

   (4) Is the flow rotational? (5%)

4. A function having period 2π is given by $f(t)=\pi+t,\quad -\pi\le t<\pi$

   [Formula of Fourier series is shown in **NOTE1**]

   (5) Find the Fourier series (15%)

   (6) Verify that $1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\cdots=\frac{\pi}{4}$ (10%)

Note1: Fourier series

$$f(x)=a_0+\sum_{n=1}^{\infty}a_n\cos\frac{n\pi x}{L}+b_n\sin\frac{n\pi x}{L},\ a_0=\frac{1}{2L}\int_{-L}^{L}f(x)dx,\ a_n=\frac{1}{L}\int_{-L}^{L}f(x)\cos\frac{n\pi x}{L}dx$$

$$b_n=\frac{1}{L}\int_{-L}^{L}f(x)\sin\frac{n\pi x}{L}dx$$

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土木工程學系 水利組　科目：流體力學　選考學生數：1　考試時間：60 min

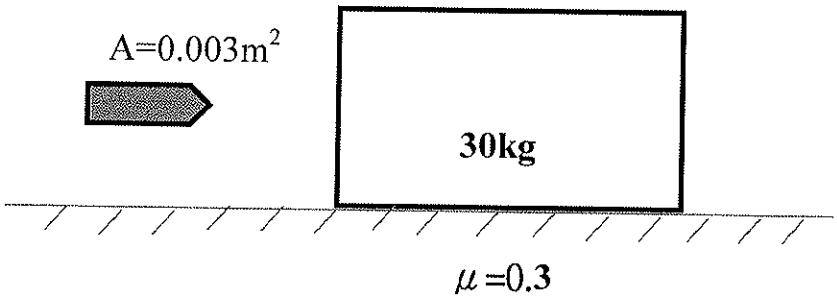
1. **請定義 Extensive property 及 Intensive property (10%)；Control Volume 及 System (10%)；並詳細(必需繪圖)推導 Reynold Transport Theorem (不夠詳細不給分)。 (30%)**

2. 如圖 1，有 30kg 物體與地面之靜摩擦係數(coefficient of kinematic friction) μ 為 0.3。欲以出口面積為 A=0.003m^2 的消防管水平噴水方式來移動原靜止在地面的此物體。

   (1) 假設水柱面積一直保持與出口時一樣，請問消防管噴嘴出口速度至少多少方使此物體開始移動？(10%) (ρ=1000kg/m^3)

   (2)若消防管噴嘴的出口速度為 10m/sec，當噴水 10sec 後，求此時物體的速度為何?(假設動摩擦係數亦為 0.3)。(25%)

圖 1



3. 如圖 2(a)為流體以不同流速之經過光滑及粗糙球體，所產生的拖曳力係數(CD，drag coefficient)與雷諾數(Re, Reynolds number)之關係。若同材質且等半徑兩個圓球分別掛於天平之左右兩側，但其表面分別是光滑(smooth)及稍微粗糙(slightly rough) (如圖 2b)。若在兩球下方同時吹以相同且均勻速度之空氣，在不同雷諾數範圍下(以 Re=105 及 3.5x105 為分界點成三區)，繪製因兩球的光滑及稍微粗糙表面(以圖中相對粗糙 1.4x10-3 為例)造成天平之傾斜狀況，並解釋其原因。

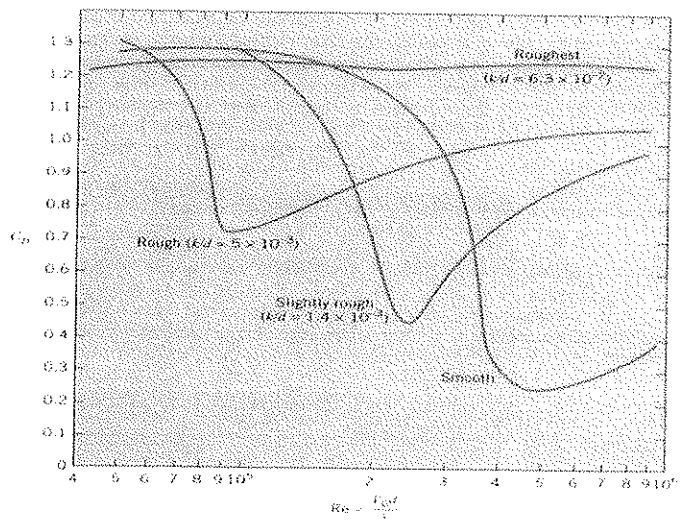


圖 2(a)

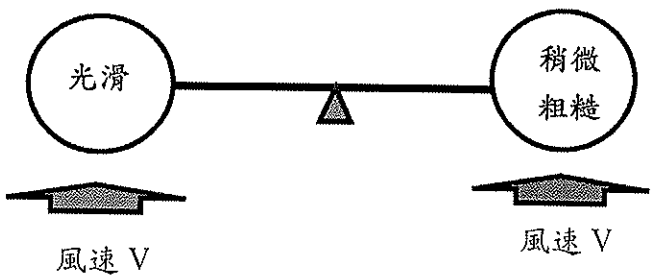


圖 2(b)

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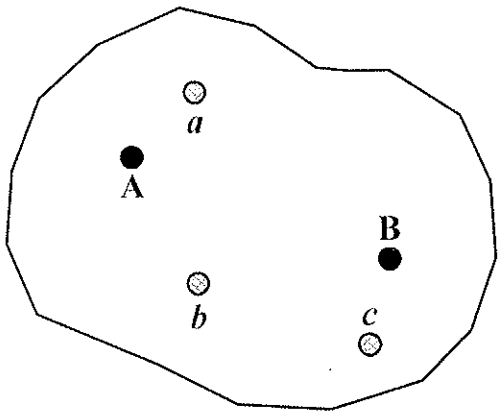
土木工程學系 水利組　　科目：水資源規劃　　選考學生數：1　　考試時間：60 min

1. Groundwater pumping results in decreased pore water pressure head. When the pressure head is decreased below a previous minimum level (preconsolidation head), the permanent (inelastic) and nonrecoverable soil compaction is occurred. A confined aquifer with two fully penetrating wells A and B is shown in right figure. The management agency wants to maximize the total pumpage to satisfy the water demand. On the other hand, since several important buildings are located at the control points *a*, *b*, and *c*, the agency tries to prevent the occurrence of inelastic soil compaction at those control points resulted from groundwater pumping. The table shown below lists the characteristics of this aquifer system.



Control points	Initial head	Preconsoildation head	Drawdown at control point at steady state due to unit pumpage	
			1.0 m^3/s at well A	1.0 m^3/s at well B
a	150 m	138 m	12.5 m	3 m
b	135 m	130 m	5.8 m	5.5 m
c	130 m	122 m	2.5 m	17

(a) Please use the response matrix technique to develop an optimal groundwater management model to satisfy the requirements of the management agency. (20%)

(b) Solve the optimal groundwater management model to find the optimal pumping rates at well A and B. (20%)

(c) Find the pressure head at each control point at steady state under the optimal pumping pattern. (10%)

2. 下表為兩個水資源開發方案，若已知資金利率為 10%，而且無須考慮稅賦支出，請使用益本比法建議應採取哪一方案？ (25%)

	方案甲	方案乙
經濟壽命	40 年	20 年
殘值	15	12
每年效益	25	22
每年營運維修成本	5	3
期初成本	300	160

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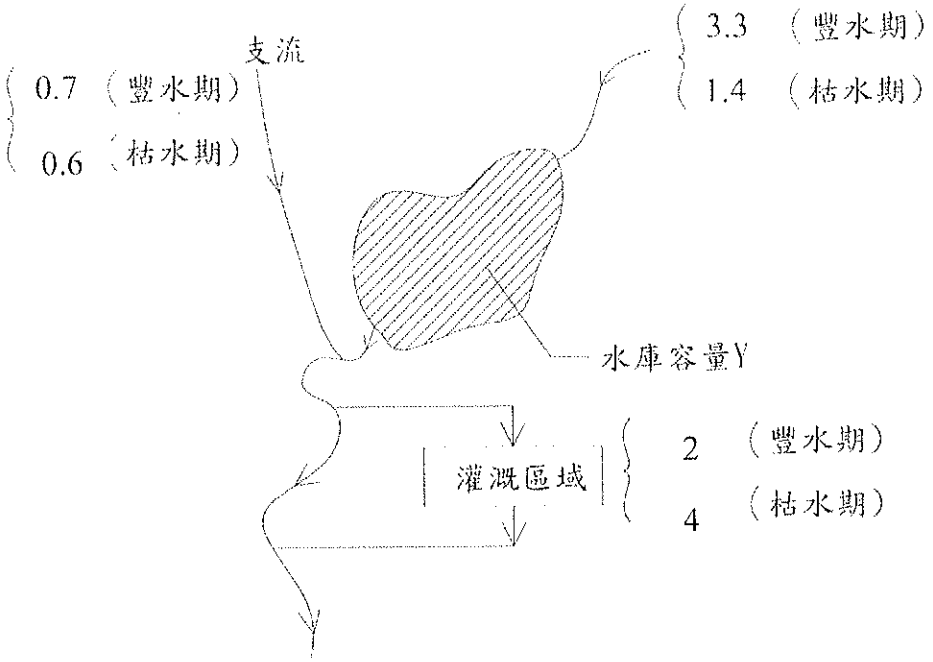
3. 有一水資源系統如下圖所示，水庫之進水量在豐水期為 3.3 單位(每單位10^8 m^3)，枯水期為 1.4 單位，水庫下游支流流入量在豐水期為 0.7 單位，枯水期為 0.6 單位。假設若灌溉需求水量豐水期為 2 單位，枯水期為 4 單位，若水庫之供水效益為(10*供水量)，而水庫投資(含營運、維護)成本之為 22*Y，Y 為水庫容量，(a).試求該水庫豐枯時期之供水操作為何，(b).在最佳利益(效益-成本)下水庫之庫容為何？其效益為何?(25%)



水源調配系統圖