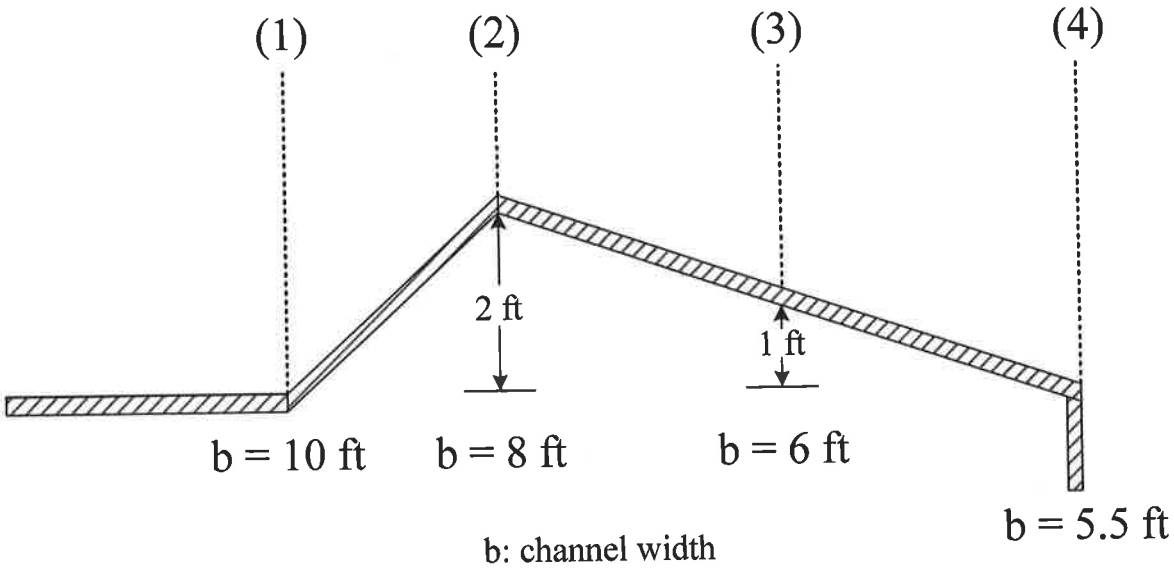
# 國立交通大學 103 學年度第 1 學期
# 博士班資格考筆試考試試題

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. Neglecting the channel resistance and the effect of non-uniformity, determine the water level in section (1) to (4) of the sketched channel transition for the rate of flow 500 cfs. Which section controls the flow? (25%)




b: channel width

2. A rectangular channel, 15 feet wide, draws water from a reservoir. The channel is of concrete (n=0.012) and has a constant slope of 0.003 for a long distance. Assume that the entrance head loss can be estimated by $0.1\left(u^2/2g\right)$, where $u$ is the mean flow at the head of the channel.
   (1) Determine the discharge when the reservoir level is 7 feet above the high point of the channel bottom (H=7 feet). (10%)
   (2) Determine the height of the reservoir level (H) at which the uniform of flow of the channel is critical. (15%)

3. Downstream from a sluice gate, a hydraulic jump produces a change in depth from 0.6 to 1.8 m in a rectangular channel. Compute the discharge per unit width of the flow. (25%)

4. Water flows with a velocity of 1.5 m/s and a depth of 3.0 m in a rectangular channel. Determine (a) the maximum size of rise in the channel bottom without affecting flow condition upstream of the rise in the bottom and (b) the depth over the rise when the height of the rise is one-half of the height in (a). Assume that energy losses can be neglected in the transition reach. (25%)

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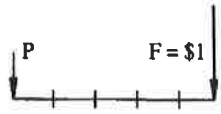
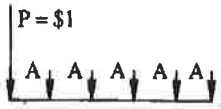
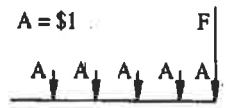
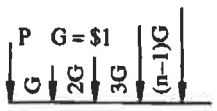
土木工程學系 水利組　　科目：水資源規劃　　選考學生數：1　　考試時間：60 min



1. 一水資源開發計畫，在第一年結束後的效益為 10,000 元，之後到第五年的效益皆以定額的方式增加，故第五年結束時的利益為 50,000 元，接著利潤持續維持在 50,000 元至第十年末，而第十一年因設施擴張利潤增為 55,000 元，直到三十年末之前利潤皆持續在 55,000 元，接著以定額的方式減少，至第 40 年結束時的利益為 0 元。請問此計劃的效益現值為多少？假設 1~10 年期間利率為 6%，11~40 年期間利率為 5%。(請參考下表之不同折算因子公式)(25%)

TABLE 2.1.1
**Summary of discounting factors**

| Type of Discount Factor | Symbol | Given* | Find | Factor | |
|---|---|---|---|---|---|
| **Single-Payment Factors** | | | | | |
| Compound-amount factor | $\left(\frac{F}{P}, i\%, n\right)$ | P | F | $(1+i)^n$ |   |
| Present-worth factor | $\left(\frac{P}{F}, i\%, n\right)$ | F | P | $\frac{1}{(1+i)^n}$ |   |
| **Uniform Annual Series Factors** | | | | | |
| Sinking-fund factor | $\left(\frac{A}{F}, i\%, n\right)$ | F | A | $\frac{i}{(1+i)^n-1}$ |   |
| Capital-recovery factor | $\left(\frac{A}{P}, i\%, n\right)$ | P | A | $\frac{i(1+i)^n}{(1+i)^n-1}$ |   |
| Series compound-amount factor | $\left(\frac{F}{A}, i\%, n\right)$ | A | F | $\frac{(1+i)^n-1}{i}$ |   |
| Series present-worth factor | $\left(\frac{P}{A}, i\%, n\right)$ | A | P | $\frac{(1+i)^n-1}{i(1+i)^n}$ |   |
| **Uniform Gradient Series Factors** | | | | | |
| Uniform gradient series present-worth factor | $\left(\frac{P}{G}, i\%, n\right)$ | G | P | $\frac{(1+i)^{n+1}-(1+ni+i)}{i^2(1+i)^n}$ |   |

*The discount factors represent the amount of dollars for the given amounts of one dollar for $P$, $F$, $A$ and $G$.

2. 下圖為兩水庫串聯之調配系統圖，其供給單一需求節點，由於入流量會隨豐枯時期而有不同，因此希望透過水庫的調節來達成穩定供水之目的，使缺水量最小，水庫操作目標可以更明確的表示為：

(1)全時刻總缺水量最小。

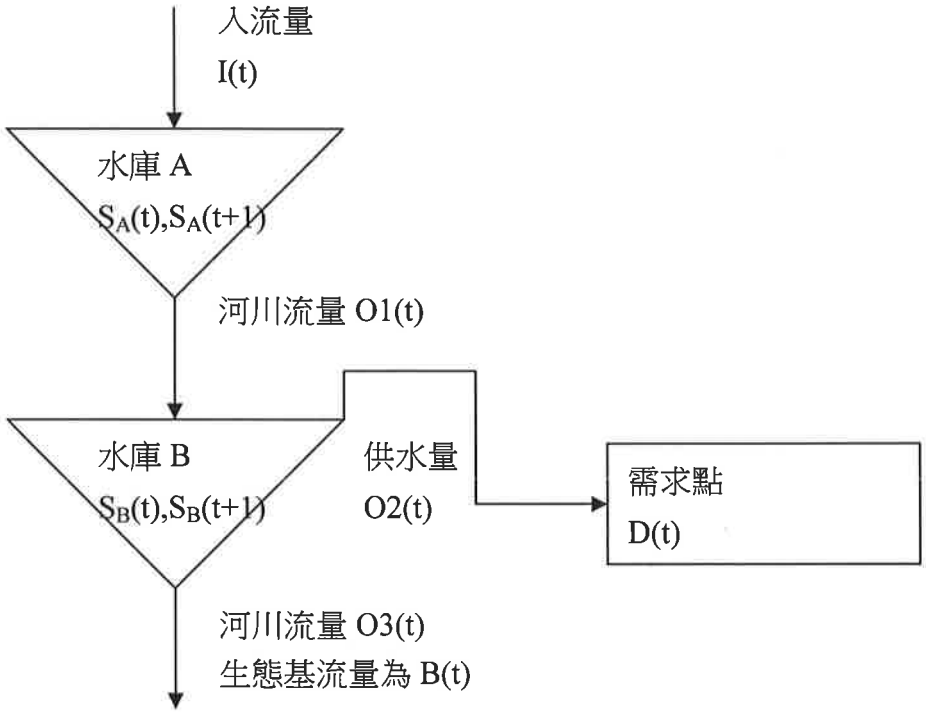
(2)避免水資源的浪費，多餘的水量必需儲存於水庫中。

除了上述目標外還需要滿足其他限制條件，其包括

- 各水庫必須滿足質量平衡式
- A、B 兩水庫之供水量和最多只供應至符合需求量

- 河川流量 O3 必須滿足生態基流量
- 各水庫蓄水量必須小於其庫容

請依下圖之定義及上述之說明，寫出其線性規劃模式。(25%)




PS: I(t), O1(t), O2(t), O3(t)表示 T 時刻*中*之入流量、供水量、河川流量

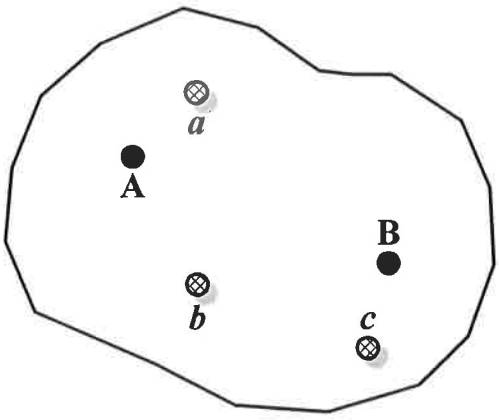
$S_A(t)$, $S_A(t+1)$ 表示 T 時刻*初*之水庫蓄水量

$S_B(t)$, $S_B(t+1)$ 表示 T 時刻*末*之水庫蓄水量

3. Please use the **Golden Section search** to find the value of $x$ that minimizes following nonlinear equation in the range [0, 2]. Locate this value of $x$ to within a **0.3** range of convergence criteria. (20%)

$$f(x)=x^4-14x^3+60x^2-70x$$

4. 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* | 50 m | 38 m | 12.5 m | 3 m |
| *b* | 35 m | 30 m | 5.8 m | 5.5 m |
| *c* | 30 m | 22 m | 4.5 m | 17 |

(1) Please use the response matrix technique to develop an optimal groundwater management model to satisfy the requirements of the management agency. (10%)

(2) Solve the optimal groundwater management model to find the optimal pumping rates at well A and B. (10%)

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

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# 博士班資格考筆試考試試題

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. If a velocity potential exist for the velocity field
   $u = a(x^2 - y^2), \quad v = -2axy + 2, \quad w = 0$
   Find it. (15%)

2. For a potential flow, the fluid velocity along a horizontal streamline is $V = U\left(1 + \frac{a^3}{x^3}\right)$, where $U$ and $a$ are constants. Determine the pressure variation along the streamline. (10%)

3. (a)寫出 Darcy-Weisbach equation 並定義符號的意義。(5%)
   (b)盡量詳細畫出 Moody chart。(10%)
   (c)詳細說明如何利用 Moody chart 尋求管流的 friction factor。(10%)

4. The Couette Flow can be described by the x-component of Navier-Stokes equation.

$$\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right) = -\frac{\partial p}{\partial x} + \rho g_x + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right)$$

   (1) What conditions are specified to simplify the above equation to have(5%)

$$0 = -\frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial y^2}\right)$$

   (2) If the upper plate moves to the right at a speed of U and the bottom plate moves to the left at a speed of U/3, find the velocity distribution following the Cartesian coordinates defined in Fig. 1. (10%)

   (3) Find the position of maximum velocity and the mean velocity. **(10%)**

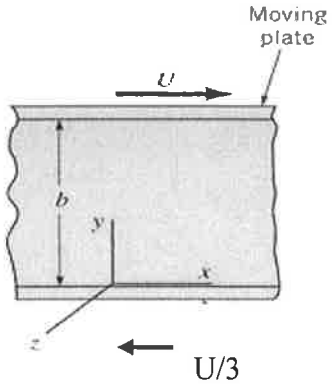


Fig. 1 For **Problem 4**

5. Experiments were carried out in a wind tunnel to measure the drag force on an object. The drag force is a function of the density, viscosity, velocity and model size, $F_D = f(D, V, \mu, \rho)$ .

(1) Using the dimensional analysis, express this equation in $\pi$ -groups. **(10%)**

(2) What is the drag force in a **water tunnel** at the condition of D=8cm and U=4m/s? **(15%)**

(NOTE: The density and kinematic viscosity of air and water are (1.2 kg/ $m^3$, $1.51\times10^{-5}$kg/ $m^3$) and (1000kg/ $m^3$,$1.14\times10^{-6}m^2/s$).

| D(cm) | U(m/s) | F(N) |
|---|---|---|
| 8 | 40 | 0.21 |
| 8 | 80 | 0.64 |
| 15 | 10 | 0.06 |
| 15 | 80 | 1.82 |

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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 2nd order ODE $y''+4y'+4y=1$, $y(0)=0$, $y'(0)=\frac{1}{2}$

   (a) By using characteristic equation. (15%)
   (b) By Laplace transform. (15%)

2. Assume

$$A=\begin{bmatrix} 1 & -1 & 1 & 4 & 1 \\ 2 & 1 & -1 & 5 & 5 \\ -1 & 2 & 1 & 1 & 3 \\ 1 & 1 & -2 & 0 & 2 \end{bmatrix}$$, rank(A)=? (20%)

3. Consider a steady flow flowing with velocity $\vec{v}(t)=-y(t)\vec{i}+x(t)\vec{j}$

   (1) Find the position vector, $\vec{r}(t)$, of the flow at any time t.

   (Hint: $\vec{r}(t)=x(t)\vec{i}+y(t)\vec{j}$; $\vec{v}(t)=\frac{d\vec{r}}{dt}$) (10%)

   (2) If some particle of the flow is initially (i.e. $t=0$) at position (1,0), where will it be at time $t=\frac{\pi}{2}$? (10%)

   (3) What is the trajectory of the flow? (5%)

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

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

4. The vibration of a beam is governed by $\frac{\partial^2 u}{\partial t^2}=c^2\frac{\partial^4 u}{\partial x^4}$ where c is a constant.

   (1) Is this equation linear and homogeneous? (5%)

   (2) How many boundary conditions or initial conditions are required to find an entire solution? Explain ! (10%)