國立交通大學 101 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：**流體力學**　選考學生數：1　考試時間：60 min

1. Determine the weight of W that can be sustained by the force acting on the piston of Fig. 1. (25%)

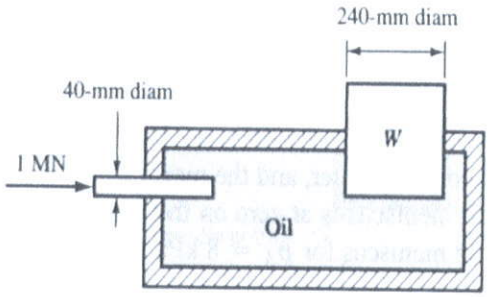

Fig. 1.

2. Given the velocity field $\mathbf{v} = 2x^2y\mathbf{i} - 3y\mathbf{j} + 8t\mathbf{k}$, determine the acceleration field of the flow. What is its value at $\mathbf{x} = 8\mathbf{i} + 12\mathbf{j}$ and $t = 6$ *sec*? (25%)

3. Given the pump shown in Fig. 2. adds 9.0 kilowatt to the water as it pumps water from the lower lake to the upper lake. The elevation difference between the lake surfaces is 10 m and the head loss is 5.0 m. Determine (a) the flowrate (15 %) and (b) the power loss associated with this flow. (10 %)

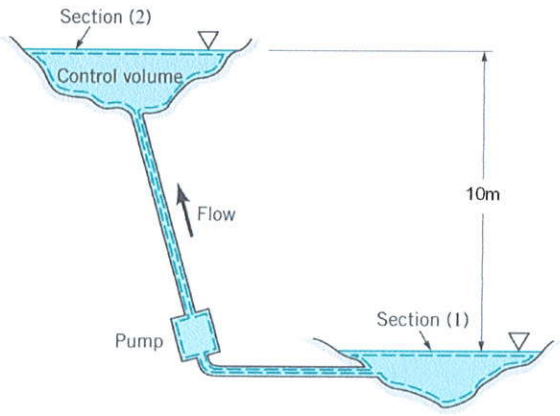

Fig. 2.

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4. Water flows at a rate of 2.0 cfs in an old, rusty 6-in. diameter pipe that has a relative roughness of 0.010. It is proposed that by inserting a **smooth plastic liner** with an inside diameter of 5 in. into the old pipe as shown in Fig the pressure drop per mile can be reduced. Is it true that the lined pipe can carry the required 2.0 cfs at a lower pressure drop than in the old pipe? Support your answer with appropriate calculations. (Fig. 3 and Moody chart) (25%)

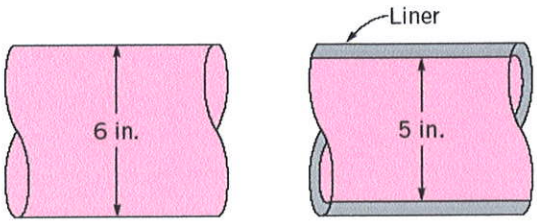
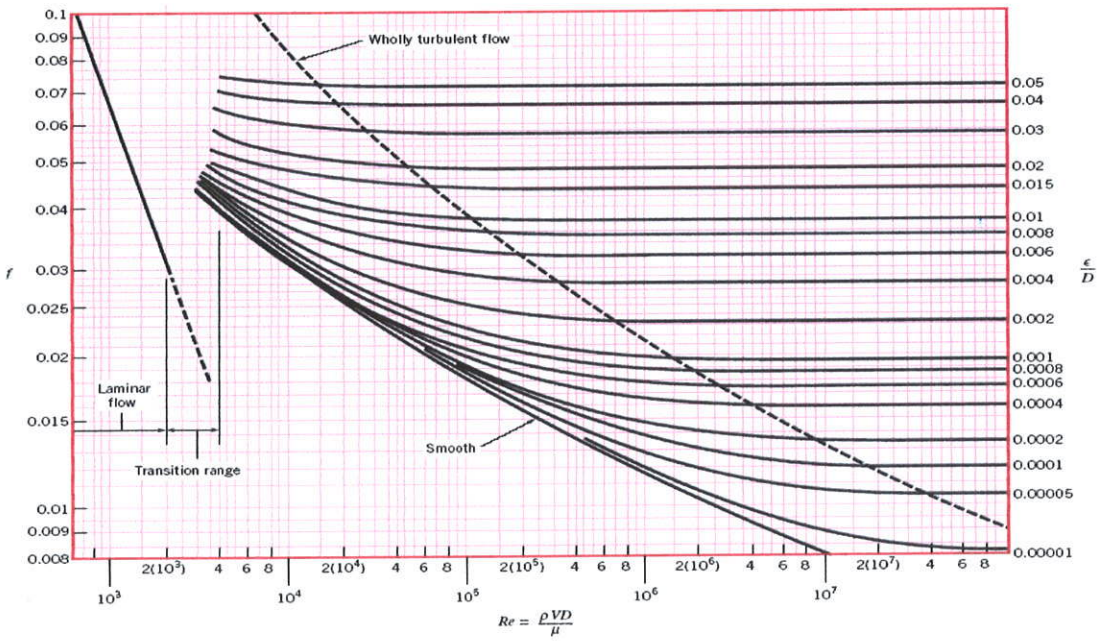


Fig. 3.



(Moody Chart)

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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. An 8-ft wide rectangular channel with a bed slope of 0.0004 ft/ft has a depth of flow of 2 ft. Assuming steady uniform flow, determine the normal depth and the critical depth if the channel has a flow rate of 100 cfs. The Manning roughness coefficient is n =0.015. (25%)
2. Consider a vertical sluice gate in a wide rectangular channel ($R = A/P = By/(B + 2y) \approx y$ because $B \gg 2y$). The flow downstream of a sluice gate is basically a jet that possesses a vena contracta **(a)** (see Figure 2). The coefficients of contraction for vertical sluice gates are approximately 0.6. Please determine the distance **L** from the contracta to a point **(b)** downstream where the depth of flow is known to be 0.5 m deep. The depth of flow at the vena contracta is 0.457 m for a flow rate of 4.646 m^3/s per meter of width. The channel bed slope is 0.0003 and Manning's roughness factor is n = 0.020. (25%)

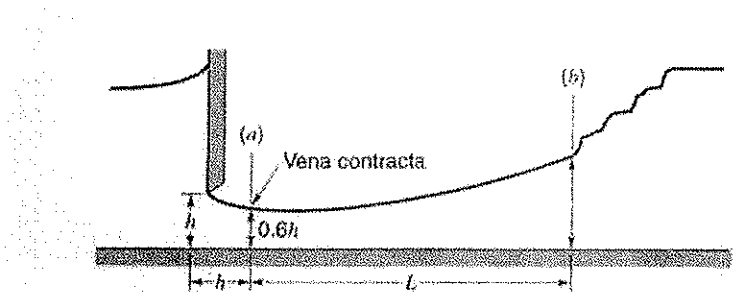

Figure 2 Flow downstream of a sluice gate in a wide rectangular channel.

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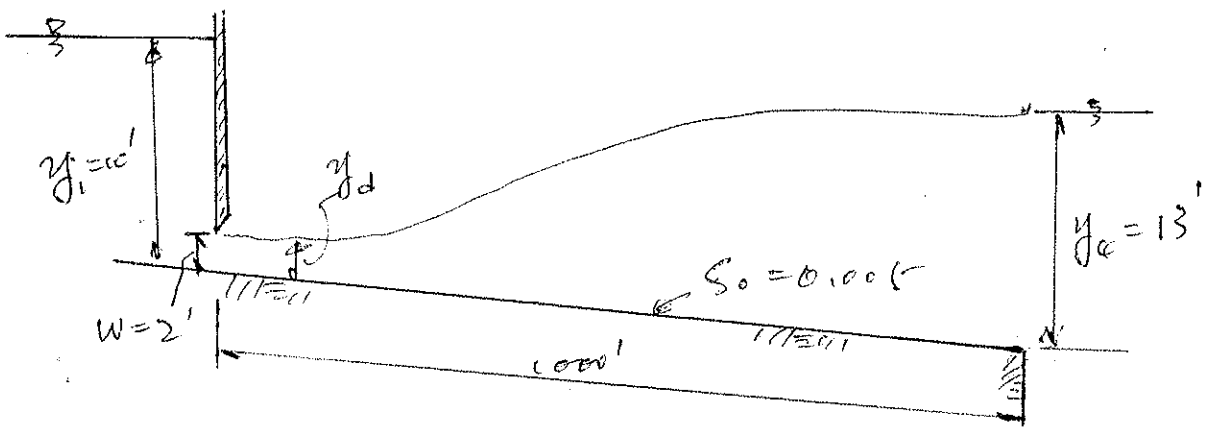
土木工程學系 水利組　　科目：**渠道水力學**　　選考學生數：1　　考試時間：60 min

3. For the flow conditions shown in the following figure and neglecting the channel bed friction:
   a. Determine the discharge assuming that the outflow from the sluice gate is free. Assume discharge coefficient Cd=0.55 and contraction coefficient Cc=0.6.(5%)
   b. Verify that the assumption of free outflow in a. is wrong.(10%)
   c. Determine the discharge when the outflow from the sluice gate is drowned.(10%)



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

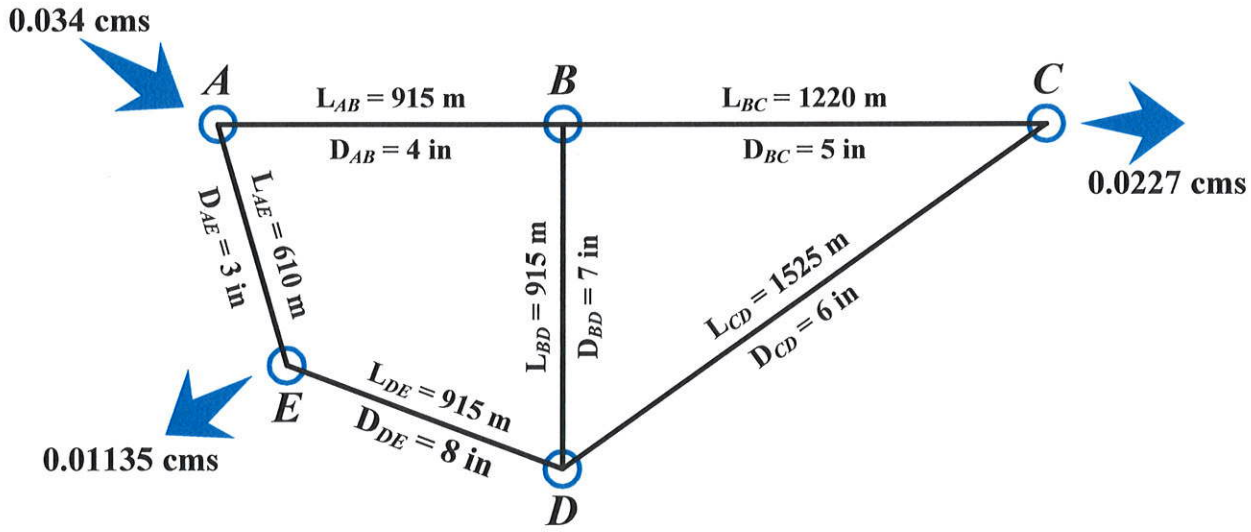
1　管路是水源調配系統(water distribution system)主要單元之一

1.1　請列舉至少三點以管路輸送水源之優點。(12%)

1.2　請列舉至少三點造成管流能量損失之原因。(12%)

1.3　請以海森—威廉(Hazen-William)公式計算下圖管網系統中各管路之流量，其中 L 代表管長，D 代表管之直徑，假設次要損失可忽略且摩擦係數 C_H 為 130。(26%)

海森—威廉公式：$h_l = \dfrac{7.92LQ^{1.85}}{(0.85C_H)^{1.85}D^{4.87}}$。$Q$ 為流量；h_l 為主要損失。



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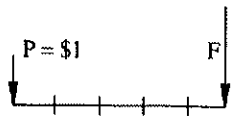
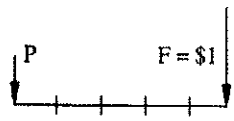
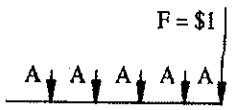
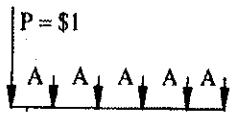
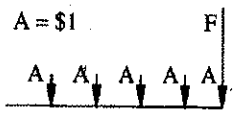
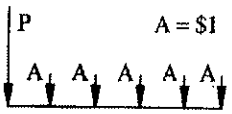
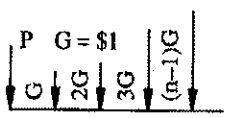
土木工程學系 水利組　　科目：**水資源規劃**　　選考學生數：1　　考試時間：60 min

2　某一水資源計劃估計在完成後至第 5 年末時每年增加 10,000 元的收益，第 6 年~第 10 年末收益維持 50,000 元，第 11 年~第 15 年末時每年又增加 10,000 元的收益，第 16 年~20 年末收益則維持 100,000 元，接著每年逐年遞減 10,000 元直至 30 年末，假設 1 至 10 年之利率為 5%，11 至 30 年之利率為 4%，請問收益現值為何？（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.

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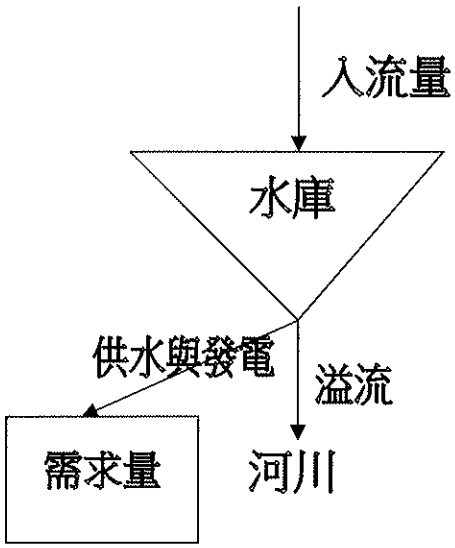
3　有一水庫其水庫總容量為 5000 萬噸，假設水庫初始蓄水量為 4500 萬噸，各時刻需求量均為 3200 萬噸，若需求量要盡量滿足，且正常供水會經由發電廠再到需求端，而溢流量則由溢洪道排到河川中，試根據下列圖表之資料計算:

(1)水庫於 t=1~3 的各時刻之供水量與溢流量。(15%)

(2)水庫於 t=1~3 的總發電量。(發電尾水位高程 60m，水路損失為總落差之 5%，水輪機及發電機之綜合效率為 85%。計算發電量時，可用每時刻之平均水頭來估算)。(10%)



時刻(旬)	入流量(萬噸)
t=1	400
t=2	100
t=3	15000

水庫水位高程與蓄水量關係	
水位高程(m)	蓄水量(萬噸)
150	5000
140	4000
130	3000
120	2000
110	1000
100	0

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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 differential equation $x^3\frac{d^2y}{dx^2}+x^2\frac{dy}{dx}-9xy=1,\ (x>0)$ (25%)

2. Find the sine half-range expansion of f(x) (25%)

$$f(x)=\begin{cases}\dfrac{2k}{L}x & 0<x<\dfrac{L}{2}\\ \dfrac{2k}{L}(L-x) & \dfrac{L}{2}<x<L\end{cases}$$

3. A linear system of three equations with three variables is shown below

$$\begin{aligned}2x+3y-7z&=3\\ x-4y+z&=0\\ 14x+21y-49z&=20\end{aligned}\quad\text{or}\quad\begin{bmatrix}2&3&-7\\1&-4&1\\14&21&-49\end{bmatrix}\begin{bmatrix}x\\y\\z\end{bmatrix}=\begin{bmatrix}3\\0\\20\end{bmatrix}\quad\text{or }\mathbf{AX=B}$$

(1) Find the determinant of matrix **A** (10%)
(2) Find the eigenvalues of matrix **A** (10%)
(3) Find the inverse of matrix **A** (15%)
(4) Fin the solution (15%)