國立交通大學 110 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：**工程數學**　選考學生數：1　考試時間: 90 min

1. For the given vector fields $\mathbf{v}_1 = \left[ye^x \quad e^x \quad 2z\right]$ and $\mathbf{v}_2 = \left[e^x \quad ye^x \quad e^z\right]$, Which vector field can be represented as the gradient of a potential? (Hint: Check if $\text{curl}\,\mathbf{v} = 0$?) Find the potential for the field if it exits? (25 %)

2. $\frac{d^2y}{dt^2} + y = 3\cos 2t$, $y(0) = 0$, $\frac{dy(0)}{dt} = 0$. Please solve by Laplace transform. (25%)

3. A path of motion is given by a vector function $\mathrm{r(t)} = \left[4\cos t, 4\sin t, 3t\right]$.

   (a) Find the length of the above vector from $\mathrm{t} = (4,0,0)$ to $\mathrm{t} = \left(0,4,\frac{\pi}{2}\right)$. (10%)

   (b) Find the tangential acceleration and the tangent of the curve as 60-degree rotation (from the initial 0 degrees). (15%)

4. The flow through the parabolic cylinder is known $\mathrm{S: y} = x^2, \quad 0 \le x \le 3, \quad 0 \le z \le 2$, with a velocity $v = \left[z^2, y, 2xz\right]$. The speed is measured in meters/sec.

   Please calculate the total amount of water passing this cylinder in 1 hour. (25%)

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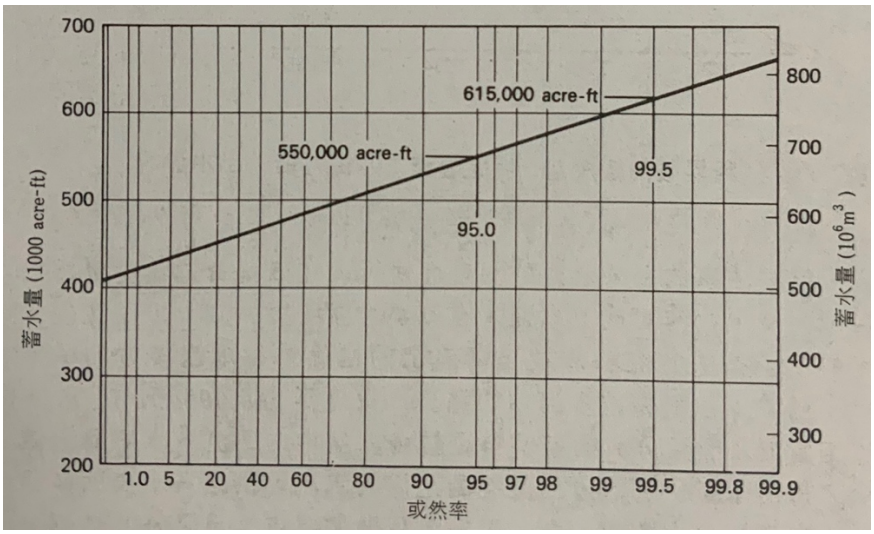
土木工程學系 水利組　　科目：水資源規劃　　選考學生數：1　　考試時間: 3hr

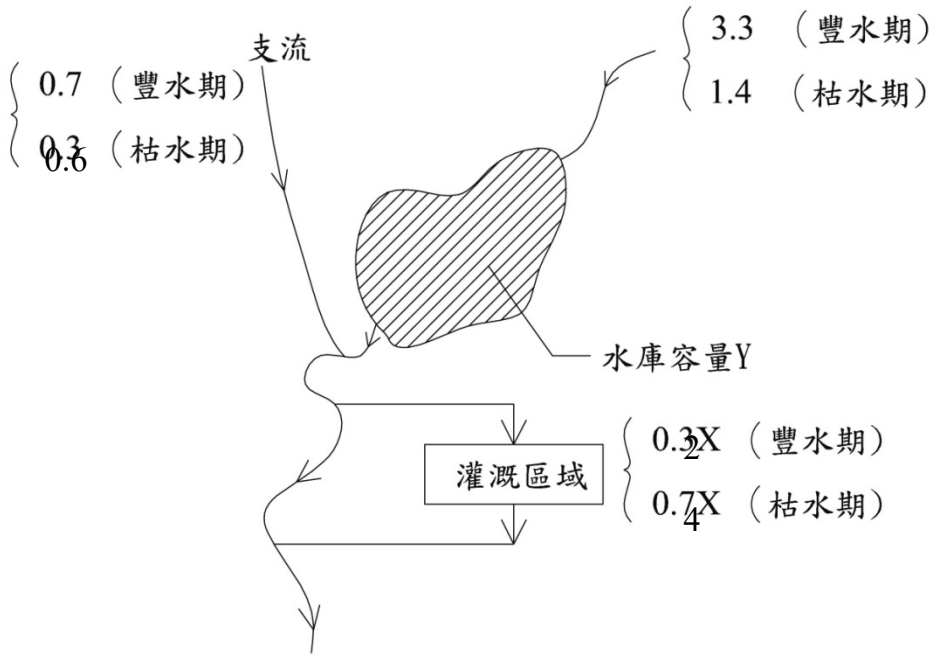
1. A reservoir is built based on the historical data such as pan evaporation, rainfall, and natural inflow (see table below). The monthly demand of this area is 3.5 x 106 m^3. You, as a water resources engineer, considers the runoff coefficient is 0.4 and average pan coefficient is 0.7. Please design a most efficient capacity of the reservoir with a minimum construction cost. (25%)

Month	Natural Inflow ($10^6 m^3$)	Rainfall ($10^6 m^3$)	Pan Evaporation ($10^6 m^3$)
1	7.80	1.85	0.80
2	7.10	1.56	0.90
3	8.40	0.80	1.00
4	3.50	0.70	1.10
5	1.50	0.50	1.50
6	0.50	0.30	1.60
7	0.20	0.04	2.60
8	5.00	1.25	2.50
9	6.90	2.00	2.20
10	7.30	2.10	2.00
11	1.70	0.00	1.00
12	0.20	0.04	0.50

2. Given an expected design life of 50 years, a reliability and storage curve for a reservoir is shown below. What is the designed reservoir storage if a design risk of 15 % is required? (25%)



3. 有一水資源系統如下圖所示，水庫之進水量在豐水期為 3.4 單位(每單位10^8 m^3)，枯水期為 1.3 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

4. 下表為兩個水資源開發方案，若已知資金利率為 6%，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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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. The flow over a steep spillway commonly produces a supercritical flow and then a subcritical flow downstream. It is only in supercritical flows that hydraulic jumps (bores) can occur. An example of hydraulic jump is shown in Fig. 1

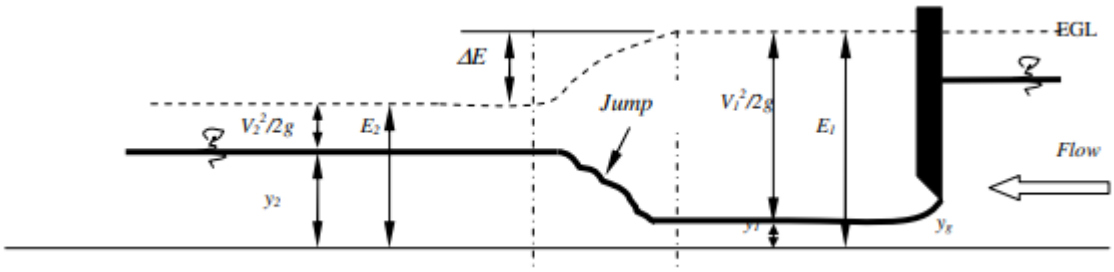

Fig. 1 Sketch of hydraulic jump

Show the relationship between the downstream and upstream depths and the energy loss of the hydraulic jump. (**30**%)

2. The spillway of a dam is 100 m wide and is designed to carry 2,000 m^3/s at flood stage. A 1:16 model is constructed to study the hydraulic jump through the spillway. Determine the required flowrate in the model. **(20%)**

3. The velocity distribution for the flow of a Newtonian fluid between two fixed parallel plates as shown below is given by the equation

$$u = \frac{3V}{2}\left[1-\left(\frac{y}{h}\right)^2\right]$$

where V is the mean velocity. The distance between the parallel plates is $2h$ and the middle of two plates is fixed at the location of y = 0. The fluid has a viscosity of 2 $N*s/m^2$. Also V = 1.0 m/s and h = 10 mm. Determine the shearing stress acting on the upper wall. (**20**%)

4. For the plane rectangular ($l \times w$ in size) shown in Fig. 2, what are the magnitude of (a) the hydrostatic force for the plate (**10**%) and (b) the **reaction force** (**20**%) at a point A in terms of γ_w and the dimensions *l* and *w*? Neglect the weight of the gates.

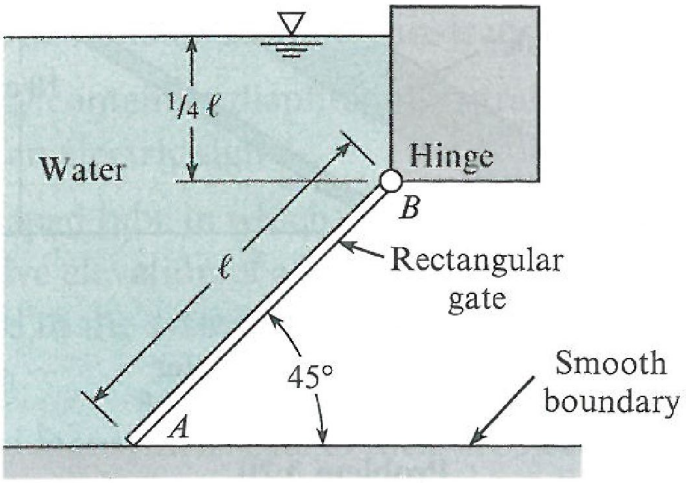

Fig. 2 for **problem 4**

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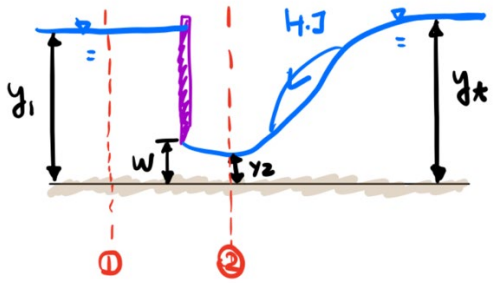
土木工程學系 水利組　　科目：渠道水力學　　選考學生數：1　　考試時間：2hr

1. A rectangular channel is 3.5 m wide and ends in a free outfall. It is known that the discharge is 10.0 m^3/s, the bed slope is 0.0025, and Manning roughness is 0.017. **Please find the water-surface profile for this nonuniform flow from a distance of 150m upstream of the outfall**. (25 points)
2. To construct a cofferdam on the downstream side of a rectangular channel, as known the weir height is 5.0 m, the weir coefficient (C_w) is 2.20, the width of this rectangular channel is 10.0 m, the bed slope is 0.008, the Manning roughness is 0.018, and the flow rate is 100.0 cms. **Please find where the energy is dispersed? And how to conduct the protection**? (25 points)
3. The figure below shows a vertical sluice gate in a horizontal rectangular channel. Given the discharge per unit width q = 0.4 $m^3/s/m$ and the upstream water depth y_1 = 1 m, **please calculate the gate opening w and the most allowable tailwater depth y_t that a repelled jump would occur.** It is assumed that the energy losses between section 1 and 2 are neglected and the contraction of coefficient C_c = 0.6. (25 points)



4. **Sketch the water surface profiles in the channel shown in the following figure**. (25 points)