1. 解 $\begin{cases} \dfrac{d^2x}{dt^2} - \dfrac{dy}{dt} = t+1 \\[2mm] \dfrac{dx}{dt} + \dfrac{dy}{dt} - 3x + y = 2t - 1 \end{cases}$　　20%

2. 請說明矩陣(matrix)與行列式(determinant)如何被發展出來，及所謂的特徵值(eigenvalue)與特徵向量(eigenvector)之意義與用途為何？(a). 10%.

　求矩陣 $A = \begin{pmatrix} 3 & 1 & -1 \\ 1 & 3 & -1 \\ 3 & 3 & -1 \end{pmatrix}$ 之反矩陣 A^{-1} 及其特徵值與特徵向量(注意：無推導而直接套公式以零分計).(b). 10%

3. 請推導 Gauss' Divergence Theorem，並說明其實際應用. 20%

4. 請以分離變數法(the method of separation of variables)導述出 $\nabla^2 \phi = 0$ 之所有可能的通解(genernal solution). 注意：包括複數(complex)情況. 式中 $\phi = \phi(x, y, z)$, $\nabla^2 = \dfrac{\partial^2}{\partial x^2} + \dfrac{\partial^2}{\partial y^2} + \dfrac{\partial^2}{\partial z^2}$. 20%

5. 求 $\displaystyle\int_0^\infty \dfrac{\cosh ax}{\cosh x}\,dx$, $|a| < 1$. 20%

1. Please give three distinguished scientists who have major contribution in the development of mechanics, and please write down their names and the major findings. (10%)

2. All the rods of structure shown in Problem-2 are force-free when the structure system is assembled. Assume that beam AC is rigid body. Please determine the force in these two rods if rod (2) is cooled down by 100° C. (20%)

3. Determine the reactions and sketch the shear and moment diagrams for the beam shown in Problem-3. Please show all the significant values (that is, maximum, minimum, positions of maximum and minimum etc.) on the diagram. Please also sketch the deflected shape of the beam. (20%)

4. As shown in sketch of Problem-4, an impermeable water retaining wall hinged at A is tilted by 30° and cable anchored at B. If the water density on both sides of the wall is 9.81 kN/m^3, please find the reactions at A and the tension force at B. (25%)

5. For a truss shown in sketch of Problem-5, please find the reactions at A and B, and also determine the forces for each member. (25%)
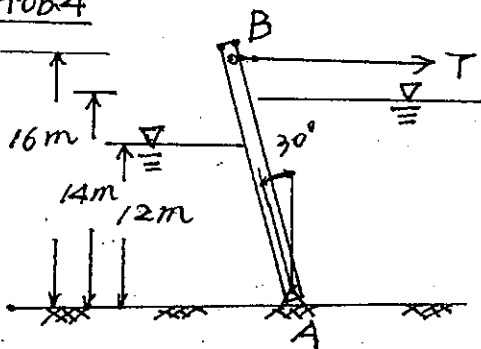

Prob.2
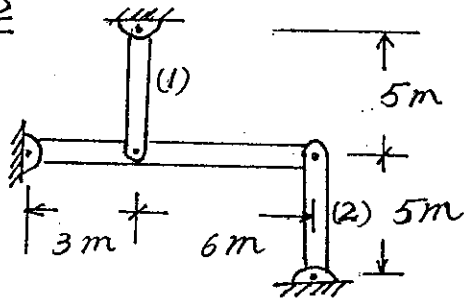
$A_1 = A_2 = 4\,cm^2$

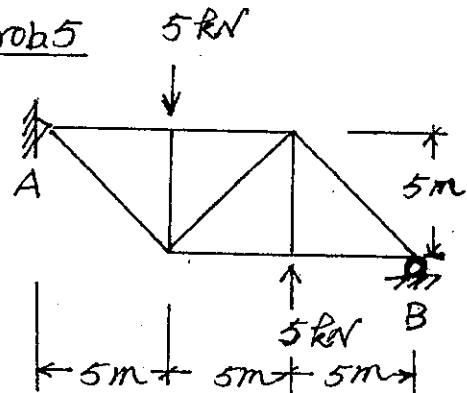$E_1 = E_2 = 5 \times 10^6\,N/m^2$

$\alpha = 5 \times 10^{-5}\,cm/cm/°C$

Prob.3
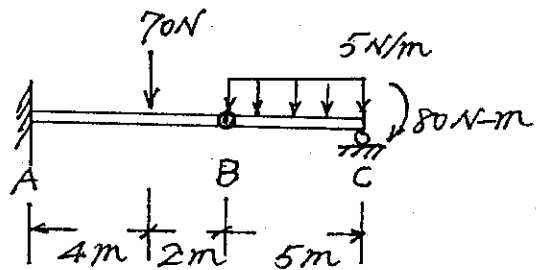
Prob.4

Prob5

1.名詞解釋，說明其物理意義或其成因？每小題4%,共10題40%.

(1).分子擴散 (molecular diffusion).　(2).牛頓流体 (Newtonian fluid)

(3).附加質量係數 (added mass coefficient)　(4).樸朗特混合長度 (Prandtl's mixing length)

(5).福祿數 (Froude number).　(6).環流量 (circulation).

(7).流線管 (stream tube).　(8).渦動擴散係數 (eddy diffusion coefficient)

(9).梯度流 (slope current).　(10).瑪哈數 (Mach number).

2.請詳導 Couette flow, 並解釋其物理意義、15%

3.請詳導述流的分離 (flow separation)的基本成因,並圖繪出其物理意義.15%

4. A 1-m-diameter cylindrical mass, M, is connected to a 2-m-wide rectangular gate as shown in picture. The gate is to open when the water level, h, drops below 2.5 m. Determine the required value for M. Neglect friction at the gate hinge and the pulley.
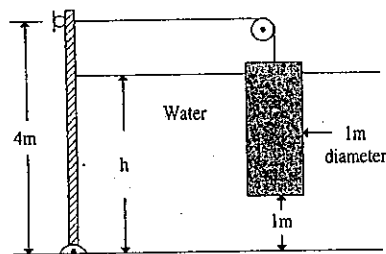
5. A uniform flow, U, in the positive x direction combined with a doublet can be used to represent flow around a circular cylinder with diameter a. This combination gives for the stream function

$$\psi = Ur(1 - \frac{a^2}{r^2})\sin\theta$$

Determine (1) the corresponding velocity potential ϕ;

(2) the pressure P_s at the surface of the circular cylinder,

$$P_s = p_o + \frac{1}{2}\rho U \ (1 - 4\sin^2\theta)$$

where P_o is the pressure far from the cylinder.

一、解釋名詞：(30%)

1. biomes
2. ecological pyramids
3. total fertility rate (TFR)
4. desertification
5. green revolution
6. estuary
7. renewable energy
8. restoration
9. oil spills
10. economic incentives

二、問答題：(70%)

1. 興建水庫有哪些負面的影響？(6%)

2. 試說明水體優養化的原因與優養限制因子。(6%)

3. 何謂微胞(micelle)？形成原理為何？(6%)

4. 關於揮發性氯化有機物與長久性有機汙染物，試各舉 2 個化合物為例。這兩類化合物各有何特性？可能產生的汙染源分別為何？(12%)

5. 何謂生物多樣性(biodiversity)？何謂基因科技(genetic technology)？何謂「生物安全議定書」？三者間之相關性如何？(15%)

6. 何謂環境荷爾蒙(environmental hormone)？對生態環境有何影響性？(10%)

7. 試述我國「土壤及地下水污染防治法」之概要。(15%)

一、解釋名詞：(20%)

1. activated sludge
2. fermentation
3. TCA cycle
4. photosynthetic bacteria
5. lithotrophs
6. *Azobacter*
7. *Thiobacillus denitrificans*
8. FC/FS ratio
9. Carlson (TSI) index
10. *in-situ* bioremediation

二、試述二種檢測水中大腸桿菌之方法。二者間有何差異性，而我國係採用何種方法？(5%)

三、試比較好氧及厭氧生物處理間之差異性。根據此差異性，闡述為何處理高濃度有機廢水宜先採用厭氣處理？(5%)

四、下列實驗數據為將已知量之活性炭加於六個燒杯中，每一燒杯有 200 ml 的生活廢水，另一燒杯不加活性炭但亦含 200 ml 生活廢水，平衡後量測得 COD，試以(1) Langmuir 與(2) Freundlich adsorption isotherm 描述，並求若以 600mg 之活性炭可吸附平衡(最終)COD 為 100mg/l 的廢水多少 mg 的汙染物。(20%)
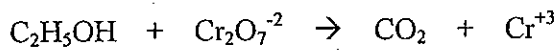
樣品	炭重(mg)	平衡(最終)COD (mg/l)
1	804	4.7
2	668	7.0
3	512	9.31
4	393	16.6
5	313	32.5
6	238	62.8
7	0	250

五、試將下列官能基(functional group)列出: alcohols, acids, ethers, aldehydes, aromatics. (10%)

六、不同年代所測得(認定)海水中微量元素之濃度(ug/l)逐年變化，如下表，可能原因何在？(5%)

|	1963	1969	1975	1983
Cu	3	3	0.5	0.25
Hg	0.03	0.03	0.03	0.001
Ag	0.3	0.04	0.04	0.003

七、請在酸性溶液中完成並平衡下列化學反應式：

$$C_2H_5OH + Cr_2O_7^{-2} \rightarrow CO_2 + Cr^{+3}$$

理論上，100 mg/l 的 C_2H_5OH 水溶液 COD 為何？ (10%)

八、(a). A chlorine dose of 1 mg/l as Cl_2 satisfactorily disinfects a water sample at pH 7. Higher or lower dose would be required to achieve the same disinfection efficiency if pH at 8? Why? (5%)

(b). How does reverse osmosis differ from a simple sieve separation or ultrafiltration process? (5%)

(c). Describe the significance of humic substances in the aquatic environment. (5%)

九、Given $Fe^{2+} + 2e \rightarrow Fe_{(s)}$ 　　　$E_H = -0.44$ V

　　　$Fe^{3+} + 3e \rightarrow Fe^{2+}$ 　　　$E_H = 0.77$ V
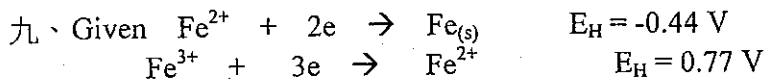
What is the E_H for the following half reaction:

　　　$Fe^{3+} + 3e \rightarrow Fe_{(s)}$ 　　　　(10%)
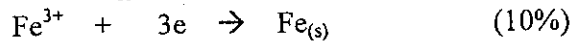
國立中山大學八十九學年度海洋環境及工程學系碩士班

「環境保護概論」考題

1. 什麼是生物多樣性（biodiversity）？生物多樣性公約（Convention on Biological Diversity）的意義和主要內容何在？國與國之間的貿易將來可能與之有何關係？（25％）

2. 我國新公布的「土壤及地下水污染整治法」的概要如何？（25％）

3. 台灣有許多河川正在或準備經營泛舟（如花蓮縣秀姑巒溪、高雄縣荖濃溪），如果你受聘為縣政府的一位環境顧問、規劃師或管理者，請問你將如何進行相關研究，哪些議題或內容應該特別注意？（25％）

4. 某一石化工業區擬建在台灣西南海岸的潟湖（參見下圖），已知該一區域冬天盛行東北風，基地南方有珍稀的冬季候鳥，北方有毗鄰漁港，該地海域優勢漂砂方向為由北向南，且目前該一海岸河口附近已呈現侵蝕現象。請問，該一工業區的興建，可能產生哪些問題或衝擊？就生態環境和規劃管理的角度，你有什麼看法？（25％）
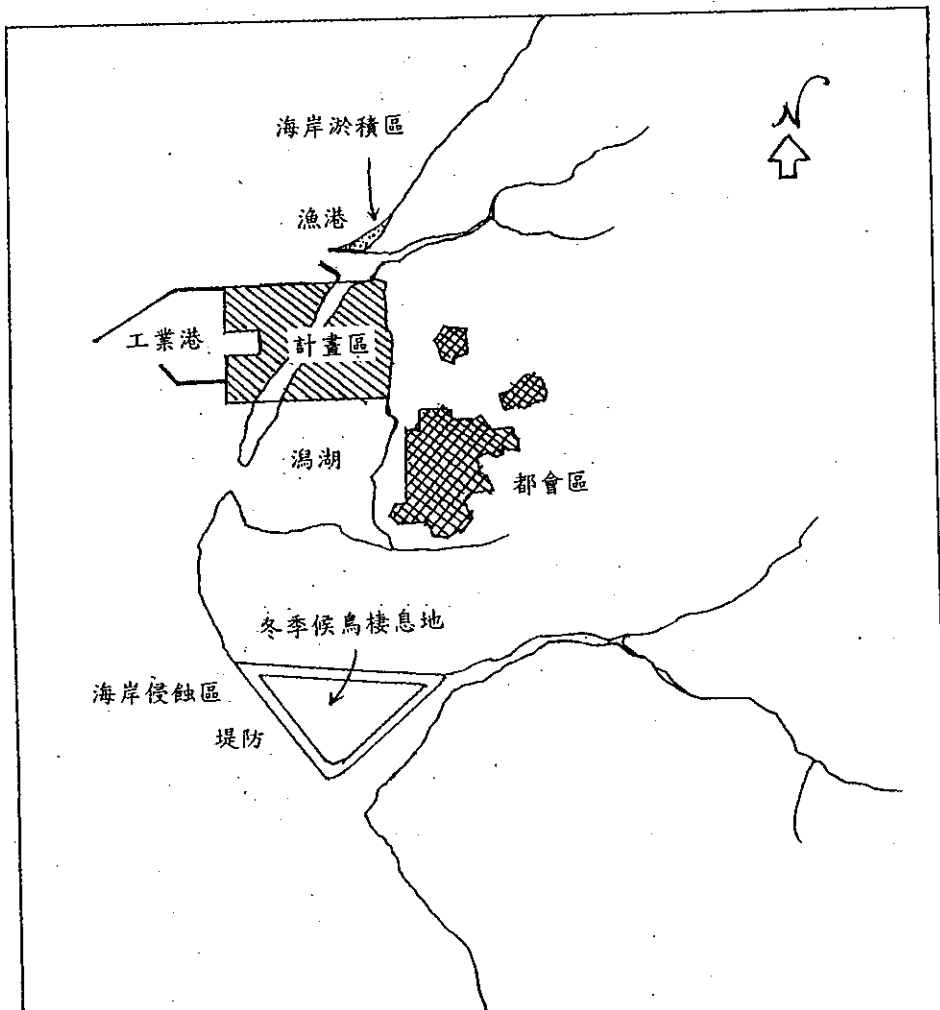
共計 100 分，請儘量陳述，空白爲零分，請注意時間。

1. 名詞解釋： (20 分)
   (A) cache memory
   (B) nonvolatile memory
   (C) National Information Infrastructure
   (D) cross-platform technology
   (E) Integrated Service Digital Network (ISDN)

2. 簡答題： (20 分)
   (A) 何謂緩衝區(buffer)，其主要功能爲何？
   (B) 何謂同步傳輸(synchronous)與非同步傳輸(asynchronous)
   (C) 何謂 parity check？其功用爲何？
   (D) 何謂 object-oriented programming language？其特性爲何？
   (E) 何謂 computer 中之 rounding error 及 truncation error？

3. 近年來市面上流行個人數位助理(PDA)，試說明其目前功能爲何？若結合無線電資料傳輸機(radio modem)，又可做那些可能之用途？　(10 分)

4. 試敘述如何利用 Internet 之搜尋引擎(search engine)來建立資料庫(database)之可行性及可能作法。　(15 分)

5. 試說明上色軟體(paint software)，例如：小畫家等，及描繪軟體(draw software)，例如：AutoCAD 等，兩類軟體之繪圖原理，並比較上述兩種軟體功能上之差異及適用場合。(15 分)

6. 若 $F(x) = x - x**3/3! + x**5/5! - x**7/7! \ldots\ldots\ldots x**N/N!$，其中 ** 代表次方。試以 Fortran，Basic，C，或 Pascal 語言，設計一程式來計算且輸出 $F(x)$ 之值，且其中 $x**N/N! > 0.01$。　(20 分)

1. (32%) Basic Concept

   a) Given the conditions that both matrices **A** and **B** are symmetric and $\mathbf{AB} = \mathbf{BA}$ (**A** and **B** commute), show **AB** is also symmetric. (8%)

   b) Verify $(\mathbf{A}^2)^{-1} = (\mathbf{A}^{-1})^2$, and $(\mathbf{A}^{-1})^T = (\mathbf{A}^T)^{-1}$. (8%)

   c) A linear system $\mathbf{Ax} = \mathbf{b}$ of m equations and n variables. State under what conditions will the linear system have solution(s), a unique solution, and infinitely many solutions? (8%)

   d) The span of three vectors $\begin{bmatrix} 1 & 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$ forms a vector space V. Try to determine the dimension of V, and explain why? (8%)

2. (13%) Evaluate the determinant $\begin{vmatrix} a+b & a & a & a \\ a & a+b & a & a \\ a & a & a+b & a \\ a & a & a & a+b \end{vmatrix} = ?$.

3. (20%) Given the matrix $\mathbf{A} = \begin{bmatrix} 1 & 1 & 3 & 3 \\ 0 & 2 & 2 & 4 \\ 1 & 0 & 2 & 1 \\ 1 & 1 & 3 & 3 \end{bmatrix}$

   a) Find the rank of matrix **A**. (10%)

   b) Consider the homogeneous linear system $\mathbf{Ax} = 0$, where **A** is given above, and $\mathbf{x} = [x_1, x_2, x_3, x_4]^T$ which is the solution vector to the linear system. The vector space of all solutions **x** is called the null space of matrix **A**. Find a basis for the null space of matrix **A**. (10%)

4. (25%) Given a matrix $\mathbf{A} = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$.

   a) Find A's eigenvalues and the corresponding eigenvectors. (7%)

   b) Verify that **A** has an orthonormal basis of eigenvectors for R^3. (5%)

   c) Compute $\mathbf{A}^{100}$. You don't have to calculate the actual values of each component in the matrix $\mathbf{A}^{100}$. (13%)

5. (10%) A real quadratic form $Q = \mathbf{x}^T \mathbf{C} \, \mathbf{x}$ and its symmetric matrix C=[c_{jk}] are said to be *positive definite* if $Q > 0$ for all $[x_1, ..., x_n] \neq [0 \, ... 0]$. A necessary and sufficient condition for *positive definiteness* is that all the determinants

$$C_1 = c_{11}, \quad C_2 = \begin{vmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{vmatrix}, \quad C_3 = \begin{vmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{vmatrix}, \cdots\cdots, C_n = \det \mathbf{C}$$

are positive. Evaluate the following quadratic form and see if they are positive definite.

a) $Q_1 = x_1^2 - 4x_1x_2 + 7x_2^2$ (5%)

b) $Q_2 = x_1^2 + 4x_1x_2 + 6x_2^2 + 2x_1x_3 - 2x_3^2$ (5%).

一、 When a fair coin is flipped, what is the chance of getting about 50% heads—specifically, between 40% and 60% (inclusive)?

　　a. for n = 10 flips

　　b. for n = 100 flips

　　c. for n = 1000 flips.

（20%）

Note how the chance of getting about 50% heads approaches certainty, as n increases. This is an example of the "law of large numbers."

二、 From a large class, a random sample of 4 grades were drawn: 64, 66, 89, and 77. Calculate a 95% confidence interval for the whole class mean μ. $(t_{0.025} = 3.18)$

（10%）

三、 Economists have long realized that GNP alone does not measure total welfare of a country. Less tangible factors are important too, such as leisure and freedom from pollution and crime. To get some idea of how these other factors vary among countries, in the 1970s a worldwide poll was undertaken (Gallup, 1976). To throw light on the issue of crime, the question was asked: "Are you afraid to walk the neighboring streets at night?" The replies were as follows:

（20%）

	United States	Japan	Latin America
Yes	40%	33%	57%
No	56%	63%	42%
No opinion	4%	4%	1%

Assuming each country's poll was equivalent in accuracy to a simple random sample of n = 300 people, find a 95% confidence interval for the difference in the percentage answering "yes":

　　a. between the United States and Japan

　　b. between the United States and Latin America

四、 In a pilot study of a new fertilizer, 4 levels were randomly assigned to 4 standard plots, resulting in the following yields of corn:

（20%）

Fertilizer X (pounds)	Yield Y (pounds)
1	70
2	70
4	80
5	100

a. Calculate the regression line of yield against fertilizer.

b. Graph the 4 points and the regression line. Check that the line fits the data reasonably well.

c. Use the regression equation to predict:

   i. The yield from 3 pounds of fertilizer.

   ii. The yield from 4 pounds of fertilizer.

   iii. The increase in yield for every additional pound of fertilizer.

Show these on the graph.

五、 In a classic example, the average annual values of hay yield Y, temperature T, and rainfall R were recorded in England over a 20 year period (Hooker, 1907; via Anderson, 1958), so that the following regressions could be calculated:

(30%)

$$\hat{Y} = 40.4 - .208T$$
$$SE \qquad (.112)$$

$$\hat{Y} = 12.2 + 3.22R$$
$$SE \qquad (.57)$$

$$\hat{Y} = 9.14 + .0364T + 3.38R$$
$$SE \qquad (.090) \qquad (.70)$$

When these regressions were calculated, estimate how much the yield would increase from one year to the next:

a. If rainfall increases 3, and temperature remains the same.

b. If temperature increases 10, and rainfall remains the same.

c. If rainfall increases 3, and temperature increases 10.

d. If rainfall increases 3, and we don't know how much temperature changes (although we know it likely will drop, since wet seasons tend to be cold).

e. If rainfall increases 3, and temperature decreases 13.

f. If temperature increases 10, and we don't know how much rainfall changes (although we know it will likely fall, since hot seasons tend to be dry).

1. (14%) About Continuity.

   a) Given a real function $f(x) = \begin{cases} x^3 & , \ if \ x < 1 \\ x^2 + ax + b, & if \ x \geq 1 \end{cases}$. If $f(x)$ is differentiable at $x=1$, find the value of constant a and b.

   b) Show that $f(x) = \sqrt{2x+1} + 2x$ is continuous at $x=3$.

2. (14%) About Limit.

   a) Given $y(x) = \sqrt{25 - x^2}$, find the value of $\lim\limits_{x \to 4} \dfrac{y(x) - y(4)}{x - 4}$ and describe the meaning of the limit in term of geometry?

   b) If $\lim\limits_{x \to a} f(x) = b$ and $\lim\limits_{x \to a} g(x) = c$, show that $\lim\limits_{x \to a} f(x)g(x) = bc$

3. (30%) About Differentiation.

   a) Given a function $f(x) = \sqrt{x}, (x > 0)$. Use the definition of derivative to calculate $f'(x)$.

   b) If $x = t - t^2$, $y = t - t^3$, evaluate $\dfrac{d^2 y}{dx^2}$.

   c) Use the first derivative and the second derivative to find the relative (local) minimum and maximum of the function $f(x) = x^3 + 3x^2 - 1$

4. (30%) About Integration.

   a) Solve the differential equation $y' = \dfrac{1 + y^2}{(1 + x^2)xy}$

   b) Evaluate $\displaystyle\int \dfrac{\sec^4 x \, dx}{\sqrt{\tan x}}$

   c) Evaluate $\displaystyle\int_0^{\pi/2} \sin x \ln(\sin x) \, dx$

5. (12%) About Infinite Series.

   a) Is an infinite series $\displaystyle\sum_{x=1}^{\infty} (-1)^x \dfrac{x}{x^2 + 1}$ convergent or divergent, explain?

   b) Find the radius of convergence for the power series $1 + \dfrac{x}{2} + \dfrac{2x^2}{2^2} + \dfrac{3x^3}{2^3} + \cdots + \dfrac{nx^n}{2^n} + \cdots$