

1. 【Ordinary Differential Equations】 30%

(a) Find the general solution of $(1 + 2e^{x/y}) dx + 2e^{x/y}(1 - x/y) dy = 0$

(b) Find a second solution of the following 2nd order linear differential equation using the given y_1 :

$$(1 - x^2)y'' - 2xy' + 2y = 0, \quad y_1 = x$$

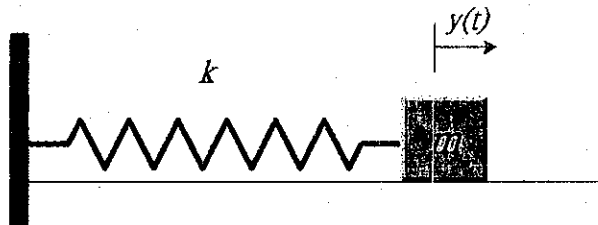
2. 【Linear Algebra】 20%

(a) A linear system $Ax = b$ of m equations and n variables. State under what conditions the linear system will have solution(s), a unique solution, and infinitely many solutions.

(b) Given a matrix $A = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$, find its orthonormal basis of eigenvectors for R^3 .

3. 【Modeling Spring Motion】 10%

Suppose that a body of mass m slides without friction on a horizontal surface as shown in the following figure. The body is attached to a spring with spring constant k (the damping force of the spring is excluded), and is also subject to viscous air resistance with coefficient γ (the higher speed, the more air resistance). Formulate a differential equation to simulate this spring motion system, and briefly describe how to solve it.



4. 【Laplace transform and solution by undetermined coefficients】 20%

(a) Solve the following linear differential equation by Laplace transform

$$y'' + 2y' + y = e^{-t}, \text{ for initial conditions } y(0) = -1 \text{ and } y'(0) = 1.$$

(b) Solve the following linear differential equation by solution of undetermined coefficients

$$y'' + 2y' + y = e^{-t}, \text{ for initial conditions } y(0) = -1 \text{ and } y'(0) = 1.$$

5. 【Fourier analysis】 10%

Find the Fourier series for a periodic square wave given by the function

$$f(x) = \begin{cases} 0, & \text{if } -2 < x < -1 \\ k, & \text{if } -1 < x < 1; p = 2L = 4, L = 2 \\ 0, & \text{if } 1 < x < 2 \end{cases}$$

6. 【Vector analysis – divergence – conservation of mass in fluid flow】 10%

Consider the flow through a rectangular box R with dimensions $\Delta x, \Delta y, \Delta z$ parallel to the Cartesian coordinate axes. The velocity vector of the fluid particle is $\mathbf{v} = [v_1, v_2, v_3] = v_1\mathbf{i} + v_2\mathbf{j} + v_3\mathbf{k}$. From conserving the flux of fluid mass entering and leaving the boundary faces of the box per unit time, derive the continuity equation of a compressible fluid flow, i.e.,

$$\frac{\partial \rho}{\partial t} + \text{div}(\rho\mathbf{v}) = 0,$$

where the divergence $\text{div}(\rho\mathbf{v}) = \frac{\rho\Delta v_1}{\Delta x} + \frac{\rho\Delta v_2}{\Delta y} + \frac{\rho\Delta v_3}{\Delta z}$.

國立中山大學九十三年度碩士班招生考試試題

科目：流體力學 (選考)

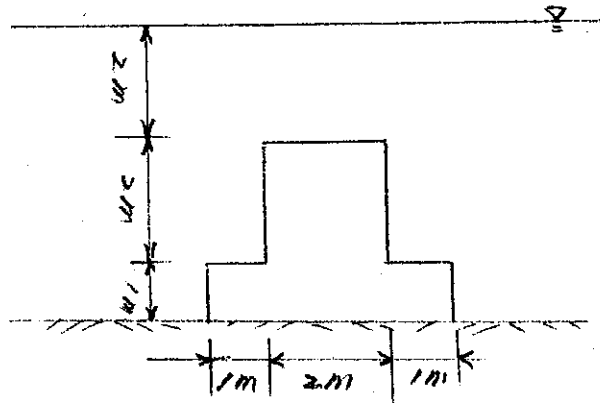
【海工系碩士班 甲組】

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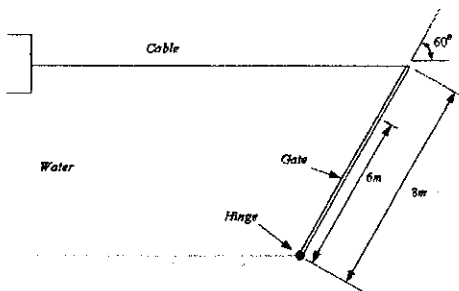
1. Terminology (3% X 10 = 30%)

- | | |
|--------------------------|--------------------------------|
| (1) D'Alembert's paradox | (2) Inviscid fluid |
| (3) Velocity potential | (4) Newtonian fluid |
| (5) Reynolds number | (6) Von Kármán's vortex street |
| (7) Irrotational flow | (8) Froude number |
| (9) Turbulence | (10) Fluid particle |

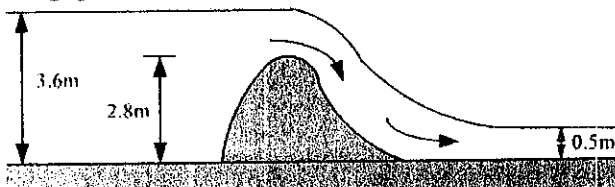
2. Compute the hydrostatic force acting on the body shown in the next figure (magnitude and direction). (10%)



3. A homogeneous, 4-m-wide, 8-m-long rectangular gate weighing 1000 kg is held in place by a horizontal flexible cable as shown next. Water acts against the gate which is hinged at point A. Friction in the hinge is negligible. Determine the tension in the cable. (Solved this problem by at least 2 different methods) (20%)



4. Water flows over the spillway shown in the next figure. If the velocity is uniform at upstream and downstream, determine (1) the flow rate assuming the spillway width is 4m; (2) the force acting on the spillway, assuming the viscous effects are negligible. (20%)



5. A velocity field is given by $\vec{V} = \left(\frac{V_0}{\ell}\right)(x\vec{i} - y\vec{j})$, where V_0 and ℓ are constants. Find (1) the possible streamlines in the first quadrant, (2) the acceleration field. (20%)

國立中山大學九十三年學年度碩士班招生考試試題

科目：工程力學（選考）

【海工系碩士班 甲組】

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1. According to Fig. 1, please find the moment of inertia of the shaded area about x-axis. (25%)
2. According to Fig. 2, where a rigid-bar BC of length L and weight W is held by 2 cables. Please find (1) the tension force for each cable and (2) the angle θ . (25%)
3. Please construct the shear force and bending moment diagram of the beam shown in Fig. 3 and please identify the location and magnitude of the maximum bending moments. (25%)
4. A prismatic bar is subjected to an axial force that produces a compressive stress of 56 Mpa on a plane at an angle $\theta = 30^\circ$. Please determine the stresses acting on all the faces of a stress element oriented at $\theta = 50^\circ$. (25%)

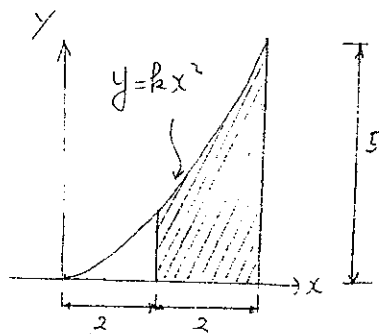


Fig. 1

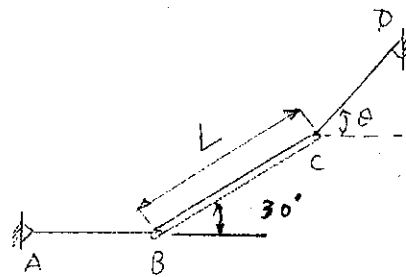


Fig. 2

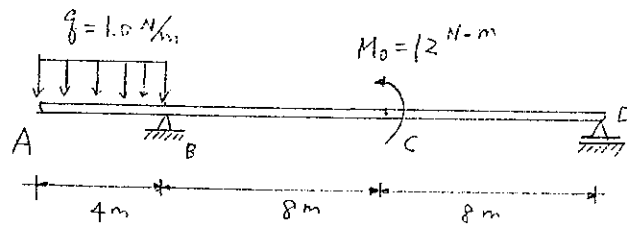


Fig. 3

國立中山大學九十三年學年度碩士班招生考試試題

科目：環境微生物學及環境化學（海工所乙組）

共 2 頁 第 / 頁

1. 試述生態系統中之氮循環(Nitrogen Cycle)中，有微生物參與之過程包含那些？試詳述各個過程中所參與之微生物名稱及生化反應式。(10%)
2. 氫氣為最近有關清潔能源(clean energy)非常熱門的一個議題，而甲烷亦為天然氣能源中之主要成分。在廢污物之厭氧生物處理反應中，將會同時產生氫氣及甲烷，二者均可純化回收提供做為能源之用，稱之微生物氣體能源(biogas energy)。試問是在何步驟會產生這些氣體？請寫出其詳細之生化反應過程及所參與之微生物名稱(10%)
3. 在好氧性活性污泥(activated sludge)生物處理過程中，根據曝氣反應槽中微生物細菌之生長狀況不同，可區分為高率(high rate)活性污泥法、傳統(traditional)活性污泥法及延長曝氣(extended aeration)活性污泥法。試繪出細菌之生長曲線(縱座標為生物質量濃度、橫座標為時間)，並將這三種活性污泥法所控制之細菌生長狀況標示在該生長曲線上。根據微生物生長特性，試分別敘述此三種活性污泥法之特性及優、缺點。(10%)
4. 請列式計算 $10^{-4.5}$ M HCl 水溶液的 pH 值為何？如果是 $10^{-6.5}$ M HCl 水溶液？如果是 $10^{-8.5}$ M HCl 水溶液？(10%)
5. COD 的量測值意義為何？請描述 COD 量測方法與原理？(10%)
6. 如果我們量測到一天的 BOD(即 BOD_1)與三天的 BOD(即 BOD_3)，我們可以藉以估計五天的 BOD(即 BOD_5)？請說明如何估計。如需要有何假設也請說明。(10%)
7. 請說明無污染大氣中雨水的主要化學成分應為何？請寫出電荷平衡式(charge balance)。並請說明如何計算估計無污染大氣中雨水的 pH 值。(10%)

國立中山大學九十三年學年度碩士班招生考試試題

科目：環境微生物學及環境化學（海工所乙組）

共 2 頁 第 2 頁

8. The sediments of an estuarine creek in New Jersey contain large amounts of mercury bound as sulfide (with $K = 10^{-52}$) under prevailing environmental conditions (pH = 6.8; Eh = -230 mV). Environmental scientists have been asked to assess the potential impacts of the polluted sediments. They conclude that the mercury poses no danger in its current state. However, they caution against any action that would expose it to air and increase its redox potential. Explain why the scientists come to this conclusion. (10%)
9. 請說明下列儀器主要用途與分析的對象(化學物質)為何? HPLC, AA, GC-Mass (10%)
10. 請寫出下列化合物的化學式或畫出結構式 (10%)
- (a) n-hexane
 - (b) pentachlorophenol
 - (c) toluene
 - (d) PCBs
 - (e) Acetic acid

國立中山大學九十三年度碩士班招生考試試題

科目： 基礎環境科學 (海工所乙組必考)

共 1 頁 第 1 頁

1. 試述農業污染對環境可能造成的影響，並提出可能的改善方案。(10%)
2. 試評估高雄市目前自來水處理系統與二年前的差異，分別說明其處理方法的特性並分析其處理功能及改善的成效。(10%)
3. 試述生態工法的內涵與規劃設計的原則並分析其與傳統工法之優缺點，舉二例說明。(20%)
4. 試述油污染對海域生態之影響。(10%)
5. (1) 試說明金屬在環境中的腐蝕現象與化學原理 (5%) (2) 試說明生物性腐蝕之腐蝕機制 (5%)
6. 解釋名詞
 - A. Rainfall Intensity-Duration-Frequency Curve (2%)
 - B. Sediment Oxygen Demand (2%)
 - C. First Flushing (2%)
 - D. Eutrophication (2%)
 - E. Oxygen Sag Curve (2%)
 - F. K_{ow} (4%)
 - G. Green House Effect (4%)
 - H. LD_{50} (4%)
 - I. Salting-out Effect (4%)
 - J. Surfactant (4%)
7. 下列兩類化合物主要的用途或來源為何？對環境分別有何不利之影響？
 - A. PCBs B. PCDDs (10%)

國立中山大學九十三年度碩士班招生考試試題

科目：線性代數（選考）

【海工系碩士班 丙組】

共 2 頁 第 1 頁

(1) (15%) Given the matrix $A = \begin{bmatrix} 1 & 4 & 2 & 4 \\ 1 & 3 & 1 & 2 \\ 1 & 2 & 1 & 1 \\ 0 & 1 & 1 & 2 \end{bmatrix}$

- (a) Find the rank of matrix A. (5%)
- (b) Consider the linear system $Ax = 0$, where A is given above, Find a null space of matrix A and its nullity. (10%)

(2) (15%) Given a matrix $A = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 1 & 1 \end{bmatrix}$.

- (a) Find the inverse of A by the method of Gauss-Jordan elimination. (5%)
- (b) Find the determinant of A. (5%)
- (c) Verify your solution of (a) by the determinant of A. (5%)

(3) (30%) Given a matrix $A = \begin{bmatrix} 3 & 5 & 3 \\ 0 & 2 & 6 \\ 0 & 1 & 1 \end{bmatrix}$

- (a) Find the eigenvalues and the corresponding eigenvectors. (15%)

(b) Given $T = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and $\hat{A} = T^{-1}AT$, please verify that A and \hat{A} are similar in terms of

their eigenvalues and eigenvectors. (15%)

- (4) (10%) Can the vector (3, -4, -6) be expressed as a linear combination of the vectors (1, 2, 3), (-1, -1, -2), and (1, 4, 5)? Show detailed explanation.

國立中山大學九十三年學年度碩士班招生考試試題

科目：線性代數（選考）

【海工系碩士班 丙組】

共 2 頁 第 2 頁

(5) (10%) Find the least-squares solution of the linear system $\begin{cases} x + y = 6 \\ -x + y = 3 \\ 2x + 3y = 9 \end{cases}$ and sketch the solution.

(6) (10%) Given $A = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$ and the determinant of A , denoted as $\det(A)$, is equal to 3, that is

$\det(A)=3$. Find the $\det(A^{-1}A^T A)$ and the $\det\begin{bmatrix} d & f & e \\ a & c & b \\ g & h & i \end{bmatrix}$.

(7) (10%) Given a quadratic form $Q = 4x_1^2 + 12x_1x_2 + 13x_2^2 = 16$, transform the Q to the principal axes y_1 and y_2 , and express $\mathbf{x}^T = [x_1, x_2]$ in terms of the new coordinate vector $\mathbf{y}^T = [y_1, y_2]$.

國立中山大學九十三學年度碩士班招生考試試題

科目：環境保護概論(海工所丙組選考)

共 / 頁 第 / 頁

- 一、什麼是“Agenda 21”？什麼是“Local Agenda 21”？地方環境問題應該如何收集相關資料和排定優先秩序？請敘述一種你認為較好的方法。(25%)
- 二、什麼是生態旅遊(Ecotourism)？什麼是生態工法(Ecototechnology or Ecological Engineering)？雖然國內外尚有不同定義和看法，但請就所知，敘述其定義和重要原則。(25%)
- 三、聯合國環境計畫署(UNEP)最近在韓國濟洲開會，其中公佈全球「海洋死亡區」近來增加到150處，而死亡區即指沒有高等海洋生物可存活的「低溶氧」海域。試問是何原因造成此區呈現溶氧不足的現象，又為何該區大多是屬於較為封閉的海灣或海域(像黑海、亞得里亞海、波羅的海及墨西哥灣等海域)？台灣附近海域有無發生死亡區之可能性？有可能的話，在何海域？為什麼？有何因應的對策？(25%)
- 四、最近監察委員曾糾正行政院，重陸輕海，長久以來輕忽我國海洋之事務。如果你(妳)是我國未來的海洋事務部部長，試問你(妳)將就保護我國海洋環境，以及永續我國海洋資源等事務的議題上，如何進行規劃？(25%)

國立中山大學九十三年度碩士班招生考試試題

科目：計算機概論

(每二所丙組選考)

共 2 頁 第 1 頁

1. 請說明下列段落所談之內容，並舉例繪圖說明 UML 之作法。(20 分)

『Object modeling methodologies, such as UML (Universal Modeling Language) and OMT (Object Modeling Technique) are becoming increasingly popular. Although these methodologies were developed mainly for software design, a major part of software design involves designing the databases that will be accessed by the software modules. Hence, an important part of these methodologies—namely, the *class diagram*—are similar to EER diagrams in many ways.

In UML class diagrams, a class is displayed as a box that includes three sections: the top section gives the class name; the middle section includes the attributes for individual objects of the class; and the last section includes operations that can be applied to these objects. Operations are *not* specified in EER diagrams.

Relationship types are called *associations* in UML terminology, and relationship instances are called *links*. A binary association (binary relationship type) is represented as a line connecting the participating classes (entity types), and may (optional) have a name. A relationship attribute, called a *link attribute*, is placed in a box that is connected to the association's line by a dashed line. The (min, max) notation is used to specify relationship constraints, which are called *multiplicities* in UML terminology.

In UML, there are two types of relationships: association and aggregation. *Aggregation* is meant to represent a relationship between a whole object and its component parts, and it has a distinct diagrammatic notation.

The operations given in each class are derived from the functional requirements of the application. It is generally sufficient to specify the operation names initially for the logical operations that are expected to be applied to individual objects of a class.』

2. 請說明下列段落所談內容，並說明 Web Databases 之問題與未來展望。(20 分)

『The Web is an important factor in planning for enterprise-wide computing environments, both for providing external access to the enterprise's systems and information for customers and suppliers and for marketing and advertising purposes. At the same time, due to security requirements, employees of some organizations are restricted to operate within intranets—subnetworks that cannot be accessed freely from the outside world. Among the prominent applications of the intranet and the WWW are databases to support electronic storefronts, parts and product catalogs, directories and schedules, newsstands, and bookstores. Electronic commerce—the purchasing of products and services electronically on the Internet—is likely to become a major application supported by such databases.

The future challenges of managing databases on the Web will be many, among them the following:

- Web technology needs to be integrated with the object technology. Currently, the web can be viewed as a distributed object system, with HTML pages functioning as objects identified by the URL.

國立中山大學九十三年學年度碩士班招生考試試題

科目：計算機概論

(海工所 丙組 選考)

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- HTML functionality is too simple to support complex application requirements. As we saw, the Web Integration Option of Informix adds further tags to HTML. In general, additional facilities will be needed to (1) make Web clients function as application front ends, integrating data from multiple heterogeneous databases; (2) make Web clients present different views of the same data to different users; and (3) make Web clients "intelligent" by providing additional data mining functionality.
- Web page content can be made more dynamic by adding more "behavior" to it as an object. In this respect (1) client and server objects (HTML pages) can be made to interact; (2) Web pages can be treated as collections of programmable objects; and (3) client-side code can access these objects and manipulate them dynamically.
- The support for a large number of clients coupled with reasonable response times for queries against very large (several tens of gigabytes in size) databases will be major challenges for Web databases. They will have to be addressed both by Web servers and by the underlying DBMSs.」

3. 請說明下列段落所談內容，並說明 deductive database 可能應用及其發展潛力。(20 分)

『In a deductive database system, we typically specify rules through a declarative language—a language in which we specify what to achieve rather than how to achieve it. An inference engine (or deduction mechanism) within the system can deduce new facts from the database by interpreting these rules. The model used for deductive databases is closely related to the relational data model, and particularly to the domain relational calculus formalism. It is also related to the field of logic programming and the Prolog language. The deductive database work based on logic has used Prolog as a starting point. A variation of Prolog called Datalog is used to define rules declaratively in conjunction with an existing set of relations, which are themselves treated as literals in the language. Although the language structure of Datalog resembles that of Prolog, its operational semantics—that is, how a Datalog program is to be executed—is still a topic of active research.』

4. What are the differences between FORTRAN 77 and FORTRAN 90? Please make sample codes to illustrate the differences. (20 分)

5. What is database software? What are the principal features of database software? What are the benefits of using database software in the field of marine environment? (20 分)

1. Find the derivative of following expressions

$$(1) y = \frac{1}{\sqrt{1+x^2} + 4} \quad (5\%)$$

$$(2) y = 2^{5x} \cdot 3^{x^2} \quad (5\%)$$

$$(3) y = x^2 \cdot \exp(x^2) \quad (5\%)$$

2. Integrate the following expressions

$$(1) \int \frac{dx}{x\sqrt{x+1}} \quad (5\%)$$

$$(2) \int \frac{dx}{2 + \cos x} \quad (5\%)$$

$$(3) \int_{-1}^1 \frac{1}{x} dx \quad (5\%)$$

3. Evaluate the following expressions

$$(1) \lim_{x \rightarrow \infty} \frac{\sqrt{x} + \sqrt[3]{x}}{x^{2/3} + 1} \quad (5\%)$$

$$(2) \lim_{x \rightarrow \infty} \frac{1 - \cos x}{x} \quad (5\%)$$

$$(3) \lim_{x \rightarrow 0} \left(\frac{1}{\sin x} - \frac{1}{x} \right) \quad (5\%)$$

4. Evaluate the line integral $\int_C 2xye^{x^2} dx + e^{x^2} dy$

over a path from (0,1) to (1,3). (Hint using $\int_a^b \nabla \phi \cdot d\vec{r} = \int_a^b d\phi$) (15%)

5. In a SARS bacteria cultivated laboratory, an expert is doing a special research to study the bacterial growth rate and its population. At the beginning, the bacterial population is 10,000, and it found that it takes 10 minutes to increase the population from 20,000 to 100,000. If the bacterial growth rate follows 'the law of natural growth', i.e. $Q'(t) = kQ(t)$, the growth rate equals to the population times a constant. Find what the total population will be after 100 minutes. (20%)
6. A tank with 1m diameter contains water depth 4m. At bottom there is an orifice hole (孔口) with 5 cm diameter. A worker forgot to close the gate valve (閘門) after finished his repairing job. How long will the tank be empty? Assume the leakage velocity is equal to $v = \sqrt{2gh}$, where g is gravity acceleration ($g=9.81 \text{ m/s}^2$), h is the water depth. (20%)

國立中山大學九十三年年度碩士班招生考試試題

科目：統計學【海洋環境及工程學系碩士班】(丙組選考)

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第一部份：數學公式/簡要說明題 【60分】

1. 【Terminology】【10分】

Statistics is a subject to deal with various scales of measurements. Please give a short definition and examples for each of the four major levels of scale.

2. 【Normal distribution】【10分】

Repeated measurements made on large samples of x_i ($i = 1$ to N) may produce a bell-shaped frequency distribution curve, called *normal distribution* $N(\bar{x}, s)$, where \bar{x} is the mean and s is the standard distribution of the samples.

- (1) Indicate the position of the *mean*, *median* and *mode* on a biased distribution curve.
- (2) If the population mean is given by μ and sample mean by \bar{x} , express statistically the variance of the population σ^2 and the limited sample s^2 .
- (3) Define the skewness (偏態) and kurtosis (峰態) mathematically using x_i , \bar{x} , s and N .

3. 【Normal distribution】【5分】

- (1) Give a general equation of the probability density function $p(x)$ for the normal distribution $N(\bar{x}, s)$.
- (2) Upon using the z -score to standardize each sample value, i.e., $z_i = (x_i - \bar{x})/s$, the standardized normal distribution $N(0, 1)$ has zero mean and the curve covers 99.73% within the range of $-3\sigma \leq z_i \leq +3\sigma$, where σ is the standard deviation of the population. What is the value of total coverage with the range $-2\sigma \leq z_i \leq +2\sigma$?

4. 【Central limits theorem】【5分】

- (1) What is the physical meaning given by the *Central Limits Theorem* for sample means?
- (2) What is the mathematical expression for the mean and the variance of the sample means \bar{x} in terms of population mean μ , variance σ^2 and total number of samples N .

5. 【Statistical tests】【15分】

Give the mathematical equation for each of the three major statistical tests, namely the t -test, the F -test and the χ^2 -test, and the main purpose of their applications.

6. 【Covariance and correlation coefficient】【5分】

From two observation data sets x_i and y_i , $i = 1$ to N :

- (1) Define the *covariance* C_{xy} in words and express it in a mathematical form.
- (2) Define the *correlation coefficient* ρ_{xy} in words and express it in a mathematical form.

7. 【Classification of deterministic data】【10分】

Deterministic data are scientific data of a physical parameter (variable) as a function of time.

- (1) Please give a broad classification of deterministic data.
- (2) What is the main purpose of applying the *Fourier Transform* on a time series data?

國立中山大學九十三年學年度碩士班招生考試試題

科目：統計學【海洋環境及工程學系碩士班】(丙組選考)

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第二部份：計算題 【40分】

8. 【Test of hypothesis and t -distribution】【10分】

We wish to test the hypothesis that a set of 10 porosity samples, $x_i = [13, 17, 15, 23, 27, 29, 18, 27, 20, 24]$ came from a parent population having a porosity of more than 18%. Assuming the samples were randomly collected from a normal population, and upon calculating the t -statistic, we wish to test the hypothesis

$$H_0: \mu_1 \leq 18\%$$

against

$$H_1: \mu_1 > 18\%$$

for a significance level α of 0.05 (i.e., it is true only one time in twenty).

STATE clearly what is the possible outcome of the test, given the critical t value equals to 1.833 for degree of freedom $\nu = 9$ and level of significance $\alpha = 0.05$.

【Hint: t -statistic is given by $t = \frac{\bar{x} - \mu_0}{s\sqrt{1/n}}$ 】

9. 【Central-4 Moving Average】【30分】

A small factory had profit from its sale of products in the past four years (2000 to 2003). Using the method of central-4 moving average to calculate the seasonal-adjusted profits from the following quarterly data x_i ($i = 1$ to 16), in million dollars:

Year	Quarter			
	Q1	Q2	Q3	Q4
2000	68	70	66	62
2001	65	67	64	58
2002	64	65	62	56
2003	62	63	60	52

- 1). First tabulate the quarterly data x_i in sequence, then use the central 4-moving average to calculate the resultant time series $A_{4,2}(i)$ for $i = 3:14$; followed by corresponding residuals $R_i = x_i - A_{4,2}(i)$ for $i = 3:14$, the overall quarterly residuals, s_1 to s_4 , and finally the seasonally-adjusted values $y_i = x_i - s_i$, for $i = 1:16$.

【Hint: for each $i = 3:14$, $A_{4,2}(i) = ((x_{i-2} : x_{i+2}) + 2(x_{i-1} : x_{i+1}))/8$ 】

- 2). Sketch roughly with a proper scale on your answer sheet the seasonally-adjusted values y_i against time i (16 quarters in the years 2000 to 2003), and x_i versus time i (1:16) on the same graph.
- 3). Observe (from the graph plotted in step 2), the variations in the quarterly profits and the seasonally-adjusted values, comment on their trends, both yearly and quarterly.
- 4). Without performing a regression analysis on the seasonally-adjusted values y_i , predict the likely profit in the first two quarters in 2004.