

1. 【Ordinary differential equation】 10%

Evaluate a general solution for the following second-order differential equation:

$$y'' - 2y' + y = x^{\frac{3}{2}}e^x$$

2. 【Ordinary differential equation】 25%

Solve the following initial value problems in second-order differential equation:

1).  $(D^2 + 2D + 10)y = 10x^2 + 4x + 2$ ,  $y(0) = 1$ ,  $y'(0) = -1$

2).  $(D^2 + 4D + 1)y = 2\cos x + 3\sin x$ ,  $y(0) = 0$ ,  $y'(0) = 0$

3. 【Partial differential equation】 20%

Linear partial differential equations,  $Au_{xx} + 2Bu_{xy} + Cu_{yy} = F(x, y, u, u_x, u_y)$  can be

classified into one of the three types: elliptic, parabolic or hyperbolic, depending on the condition of  $B^2 - 4AC$ .

1). Indicate how the condition of  $B^2 - 4AC$  is linked to each of these three types and also provide a typical mathematical equation for each of them.

2). Prove  $u = 2xy/(x^2 + y^2)^2$  is a solution to the Laplace equation.

4. 【Laplace transform】 15%

Solve the following initial value problem by the Laplace transform

$y' - 5y' + 6y = r(t)$ , where  $r(t) = 4e^t$ , for  $0 < t < 2$ , and  $r(t) = 0$ , for  $t > 2$ ;  
with initial conditions  $y(0) = 1$ , and  $y'(0) = -2$ .

5. 【Fourier analysis】 10%

Find the Fourier series of  $f(x) = e^{2x}$  on  $[0, 1]$ .

6. 【Vector analysis】 10%

Evaluate the surface integral  $\iint_S (\text{curl } \mathbf{F}) \cdot \mathbf{n} dA$ , given

$\mathbf{F} = [-e^y, e^z, e^x]$ ,  $S$  the square  $0 \leq x \leq 1$ ,  $0 \leq y \leq 1$ ,  $z = x + y$

7. 【Residue integration】 10%

Evaluate the following integral  $\oint_C \frac{e^{-z^2}}{\sin 4z} dz$

# 國立中山大學九十二學年度碩士班招生考試試題

科目： 工程力學 (海洋環境及工程學系碩士班甲組選考)

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1. According to Fig.1 please determine the moment of inertia of the shaded area about the x-axis. (10%)
2. As shown in Fig.2 is a prismatic bar weight  $W$  sitting in a bowl, where the length of the bar is  $3R$  and  $R$  is the radius of the bowl. Please find the angle  $\theta$  when this bar is in equilibrium if (a) the surface of the bowl is frictionless, (b) the friction coefficient of the surface inside the bowl is  $\mu_A$ . (20%)
3. As shown in Fig.3 is a water dam subjected to the water pressure. For 1 m thickness of dam, please find (a) the reaction force of the dam to the water pressure, and (b) the equivalent force and couple at the front tip A of the dam. (20%)
4. Please describe the principle of Hook's Law. Please design an experiment for rubber and describe whether the rubber satisfies Hook's Law or not according to the data obtained from your experiment. (20%)
5. Please solve the reactions of the beam shown in Fig.4 and plot shear force diagram and bending moment diagram. (30%)

Fig.1

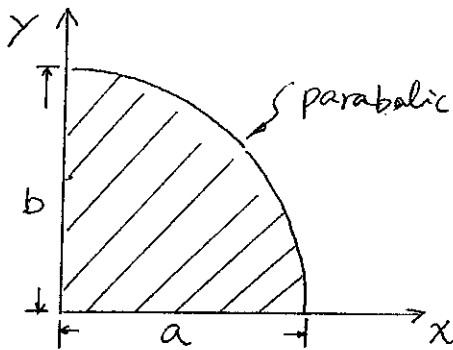


Fig.2

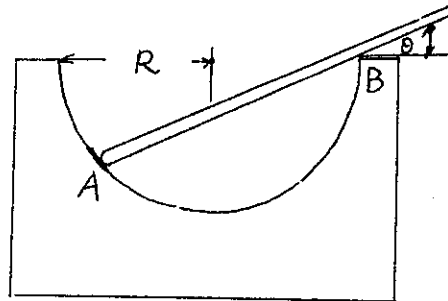


Fig.3

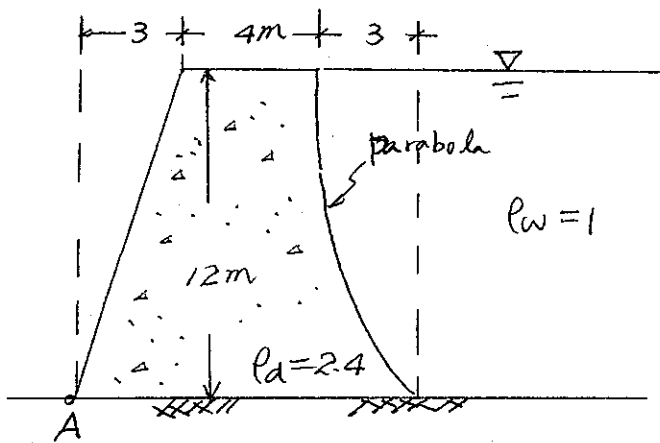
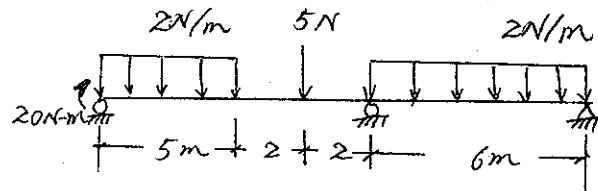


Fig.4



1、解釋名辭(10x4%=40%)

- (1). Newtonian fluid
- (2). Buoyancy
- (3). Cavitation
- (4). D'Alembert's paradox
- (5). Form drag
- (6). Mean free path
- (7). Strouhal number
- (8). Drag crisis
- (9). Velocity potential
- (10). Lift force

2、求解圓形管內的層流速度分佈。(20%)

3、導述描述流体運動之 Eulerian 與 Lagrangian 方式的時空微分性質的差異。(20%)

4、導述流体運動時之四種運動量。(20%)

1. 解釋名詞

- A. Acid Rain (2%)
- B. Hydraulic Retention Time (2%)
- C. First Flushing (2%)
- D. Marine Outfall (2%)
- E. Intensity-Duration-Frequency Curve (2%)
- F. Limiting nutrient for eutrophication (5%)
- G. Bioconcentration factor (5%)
- H. Thermal stratification (5%)
- I. Environmental half-life (5%)
- J. Reverse osmosis (5%)
- K. Persistent organic pollutants (5%)

2. 今年四月初梧棲鎮發生化學儲槽車毒液外洩，請討論類似事件對環境生態之影響。

(10%)

3. 試述水處理系統(自來水及污水)中沉澱池的種類，並分別說明其特性並分析其功能及改善的方法。(20%)

4. 試述高雄市的愛河與前鎮河的環境現狀，請分析其成因並提出改善方案。(10%)

5. 試述固體廢棄物的處理方法及分析其優缺點，並提出您對環保署施行「禁用塑膠袋」政策的看法。(10%)

6. 下列兩類化合物主要的用途為何？對環境分別有何不利之影響？

A. chlorofluorocarbons B. organotins (10%)

1. 何謂鹼度(alkalinity)? 在廢水處理時量測鹼度意義何在? 試舉一例說明鹼度較高 pH 值不一定較高。(10%)
2. 膠凝劑應用於水及廢水處理上的機制為何?(10%)
3. Please explain (15%)
  - A. Standard hydrogen electrode
  - B. Humic substances
  - C. critical coagulation concentration
4. 對於一個受金屬污染的地下水域, 土壤的 CEC (cation-exchange capacity) 扮演的角色為何? 土壤的 ECS (exchangeable cation status) 代表的又是何種意義?(10%)
5. 請討論廢水中或廢棄物掩埋場中的 complexing agents 會造成哪些困擾?(10%)
6. 假設將一杯純水放置於大氣中, 請寫出水中各物種之電荷平衡式(charge balance)。(5%)
7. Please construct (with explanations) a pE-pH diagram for iron.  
Consider the following reactions only:  
$$\text{Fe}^{+3} + e^{-} = \text{Fe}^{+2} \quad pE^0 = 16$$
$$\text{Fe}^{+2} + 2e^{-} = \text{Fe} \quad pE^0 = -7$$
$$0.25 \text{O}_2 + \text{H}^{+} + e^{-} = 0.5 \text{H}_2\text{O} \quad pE^0 = 20$$
$$\text{H}^{+} + e^{-} = 0.5 \text{H}_2 \quad pE^0 = 0 \quad (10\%)$$
8. 以下三種細菌在生理特性上均屬於同一屬, 試依據其代謝特性之不同加以比較這三種菌株, 並列出其代謝之生化反應式。(10%)

*Thiobacillus thiooxidans*     *Thiobacillus ferrooxidans*  
*Thiobacillus denitrificans*
9. 何謂優養化(eutrophication)? 優養化形成原因之作用機制為何? 其對環境造成的影響又為何? 如何判定水域是否遭受到優養化? 有何方法控制(control)優養化的發生? 又一但發生優養化時, 需用何種方法治理之?(10%)
10. 試說明革蘭氏染色(Gram stain)之實驗步驟及其原理。(10%)

- 一、屏東東港有三寶，人說「黑鮪魚、櫻花蝦、油魚子」。請就所學所知，從自然保育和海洋生態系統的角度，說明你對於這些資源永續利用和活化地方經濟的看法 (25%)
  
- 二、什麼是 conservation, preservation, treatment, disposal, planning? 請舉台灣任何一個最新版的環境保護立法為例，大要說明其立法宗旨和基本內容架構(25%)
  
- 三、何謂「生態工法」? 其與傳統工法相較有何差異性? 試就海岸保護為例，傳統工法係如何進行，而又有何優缺點? 如改以生態工法進行，應如何進行? 其又有何優缺點? (20%)
  
- 四、最近「美伊戰事」中，其中一段期間美英聯軍深受「砂塵暴」所苦，而台灣近來亦深受中國大陸來的「砂塵暴」的影響，空氣品質不佳。試問何謂「砂塵暴」? 而中國大陸「砂塵暴」的起因又為何? 當地政府有無對策? 此一對策你認為如何? 試陳述你對消彌「砂塵暴」的見解。(20%)
  
- 五、近來台灣「核四」議題又被提出，又引發台灣到底需不需要再興建新的核電廠之爭議。試就各個角度及核電之優缺點陳述你的看法。如不建核電廠，又有何替代方案，可以解決我國對能源之需求呢? (10%)

1. 請說明下列段落所談之內容，並說明 web model 未來可能之發展模式。(20 分)

『The Web model has been more rapidly and widely adopted than any other approach to building distributed applications to date. The phenomenal success of the Web model can be attributed to one core characteristic: it is more loosely coupled than traditional distributed programming models like RPC, DCOM and CORBA. The interactions between Web clients and servers are simple: they exchange messages that carry MIME-typed data, and the semantics of a message can be modified using headers. The destination of a message is specified indirectly using a URL, and this level of indirection can be leveraged to implement load balancing, session tracking and other features.

The simplicity of the interactions in the Web programming model makes it possible to build systems incrementally. Unlike tightly-coupled RPC and distributed object systems, which require all the pieces of an application be deployed at once, you can add clients and servers to Web-based systems as needed. You can establish connections to new applications fairly easily. And you can do all of this in a decentralized manner, without any central coordination beyond the registration of DNS names, and with a degree of interoperability, scalability and manageability that is remarkably high.

The basic idea behind Web services is to adapt the loosely coupled Web programming model for use in applications that are not browser-based. The goal is to provide a platform for building distributed applications using software running on different operating systems and devices, written using different programming languages and tools from multiple vendors, all potentially developed and deployed independently. 』

2. 請說明下列段落所談內容，並比較 OO Database 與 relational DB 差異。(20 分)

『One goal of OO databases is to maintain a direct correspondence between real-world and database objects so that objects do not lose their integrity and identity and can easily be identified and operated upon. Hence, OO databases provide a unique system-generated object identifier (OID) for each object. We can compare this with the relational model where each relation must have a primary key attribute whose value identifies each tuple uniquely. In the relational model, if the value of the primary key is changed, the tuple will have a new identity, even though it may still represent the same real-world object. Alternatively, a real-world object may have different names for key attributes in different relations, making it difficult to ascertain that the keys represent the same object (for example, the object identifier may be represented as EMP\_ID in one relation and as SSN in another). 』

3. What is database software? What are the principal features of database software? What are the benefits of database software? (20 分)

4. What is Artificial Intelligence (AI)? What can be the benefits of AI applications to marine environment and engineering? (20 分)

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

『XML is subset of the Standard Generalized Markup Language (SGML) defined in ISO standard 8879:1986 that is designed to make it easy to interchange structured documents over the Internet. XML files always clearly mark where the start and end of each of the logical parts (called *elements*) of an interchanged document occurs. XML restricts the use of SGML constructs to ensure that fall back options are available when access to certain components of the document is not currently possible over the Internet. It also defines how Internet Uniform Resource Locators can be used to identify component parts of XML data streams.

By defining the role of each element of text in a formal model, known as a *Document Type Definition (DTD)*, users of XML can check that each component of document occurs in a valid place within the interchanged data stream. An XML DTD allows computers to check, for example, that users do not accidentally enter a third-level heading without first having entered a second-level heading, something that cannot be checked using the HyperText Markup Language (HTML) previously used to code documents that form part of the World Wide Web (WWW) of documents accessible through the Internet.

However, unlike SGML, XML does not require the presence of a DTD. If no DTD is available, either because all or part of it is not accessible over the Internet or because the user failed to create it, an XML system can assign a default definition for undeclared components of the markup.

XML allows users to:

- bring multiple files together to form compound documents
- identify where illustrations are to be incorporated into text files, and the format used to encode each illustration
- provide processing control information to supporting programs, such as document validators and browsers
- add editorial comments to a file.

It is important to note, however, that XML is not:

- a predefined set of tags, of the type defined for HTML, that can be used to markup documents
- a standardized template for producing particular types of documents.

XML was not designed to be a standardized way of coding text: in fact it is impossible to devise a single coding scheme that would be suit all languages and all applications. Instead XML is formal language that can be used to pass information about the component parts of a document to another computer system. XML is flexible enough to be able to describe any logical text structure, whether it be a form, memo, letter, report, book, encyclopedia, dictionary or database.』



1. (10%)

(a) Given a  $n \times n$  matrix  $A$ , explain the fact that if  $\det A \neq 0$ , then  $A^{-1}$  exists (5%)(b) Will the three vectors  $[1 \ 1 \ 0]$ ,  $[0 \ 1 \ 1]$ ,  $[1 \ 0 \ 1]$  form a basis for the vector space  $R^3$ ? Explain your answer. (5%)2. (10%) Given  $A = \begin{bmatrix} 1 & 2 & -1 & 4 \\ 0 & 1 & -2 & 3 \\ -1 & 0 & -3 & 2 \end{bmatrix}$ , find the rank of  $A$  and the basis for the rowspace. If  $A$  is the coefficient matrix of a non-homogeneous linear system, how many solution(s) can you expect?

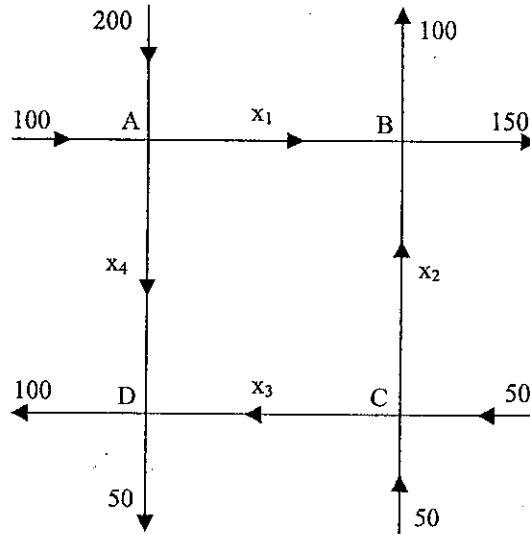
3. (20%) Solve the following linear system using both Cramer's rule and LU decomposition.

$$\begin{cases} x_1 + 4x_2 + 2x_3 = 5 \\ x_1 + 4x_2 - x_3 = 2 \\ 2x_1 + 6x_2 + x_3 = 7 \end{cases}$$

4. (30%)

(a) Given the quadratic form  $Q = 3x_1^2 + 2x_1x_2 + 2x_1x_3 + 4x_2x_3 = \mathbf{x}^T \mathbf{C} \mathbf{x}$ . Find the symmetric coefficient matrix  $\mathbf{C}$ . (5%)(b) Find  $\mathbf{C}$ 's eigenvalues and the corresponding eigenvectors. (10%)(c) Verify that one set of eigenvectors of  $\mathbf{C}$  can form an orthonormal system. (5%)(d) Compute  $A^{100}$ . (10%)5. (15%) A company has warehouses in New York, Boston, and Los Angeles. Each month  $2/5$  of the contents of New York is sent to Boston and Los Angeles,  $1/3$  of the contents of Boston are sent to New York and Los Angeles, and  $1/4$  of the contents of the warehouse of Los Angeles are moved to New York and Boston. Find the eventual distribution of the company's inventory.

6. (15%) Construct a mathematical model that describes the traffic flow in the road network of the following figure. All streets are one-way streets in the directions indicated. The units are in vehicles per hour. Given two distinct possible flows of traffic. What is the minimum possible flow that can be expected along the branch AB? (Hint: balance of vehicle flow at each junction)



# 國立中山大學九十二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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## 第一部份：數學公式/簡要說明題 【40分】

### 1. 【Regression analysis】【12%:6, 3, 3】

Mean value  $\bar{x}$  and regressed values  $\hat{x}_i$  can be calculated from a set of statistical data  $x_i$ ,  $i = 1$  to  $n$ .

- 1). Define the variance  $Var(x)$  in words and express it in a mathematical form.
- 2). What is the basic principle behind a regression analysis?
- 3). What is the *goodness-of-fit*  $R^2$  and express it in terms of  $x_i$ ,  $\bar{x}$  and  $\hat{x}_i$ .

### 2. 【Covariance and correlation coefficient】【6%:3, 3】

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*  $\rho_{xy}$  in words and express it in a mathematical form.

### 3. 【ANOVA】【9%:3, 6】

- 1). What does the acronym *ANOVA* stand for?
- 2). What are the main objectives of the *ANOVA*?

### 4. 【Central limit theorem】【13%:3, 3, 7】

Assume the total discharge ( $z$ ) at a section of a river is the sum of the surface runoff ( $x$ ) and ground water discharge ( $y$ ). From the sampled data available, it has been found that the surface runoff and ground water discharge have the following means and standard deviations,  $\bar{x}$ ,  $s_x$ ,  $\bar{y}$  and  $s_y$ , respectively. Express the mean and standard deviation of the total discharge and estimate the total discharge  $z$  to within a probability of 5% (which gives the cumulative probability of 1.65 from a standardized normal distribution).

## 第二部份：計算題 【60分】

### 5. 【Probability : Binomial distribution】【12%:3, 3, 3, 3】

Consider a five-well (oil) exploration program in a virgin basin in Taiwan Strait where the success ratio of discovering an oil well is about 10%. What is the probability :

- 1). That the entire program will be a total failure?
- 2). That one well will come in during the five-hole drilling program?
- 3). Of discovering two wells in a two-hole exploration?
- 4). Of two successes in a five-hole exploration?

# 國立中山大學九十二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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6. 【Test of hypothesis, Central limit theorem and  $t$ -distribution】【9 $\frac{3}{8}$ : 3, 3, 3】

A parent population has a mean of  $\mu_0 = 14.2$  mm and standard deviation  $s = 4.7$  mm. Now, apply the principle of central limit theorem to test whether a sample observation of six values that has a sample mean of  $\mu_1 = 30.0$  mm is drawn from the same parent population, for the significance level  $\alpha = 0.05$ .

7. 【ANOVA and  $F$ -distribution】【12 $\frac{3}{8}$ : 9, 3】

Moisture content versus depth in a core soil sample of mud in a locality in Kaohsiung is:

Depth  $x_i$  (m) : 0, 5, 10, 15, 20, 25, 30, 35

Moisture  $y_i$  (%) : 124, 78, 54, 35, 30, 21, 22, 18

1). Use an ANOVA table and  $F$ -distribution to test whether a linear regression is sufficient to represent the relationship between the depth and moisture content. This can be done by comparing the  $F$ -test with a theoretical value from the  $F$ -distribution table,  $F(\nu_1, \nu_2, \alpha) = 5.99$ , where  $\nu_1$  and  $\nu_2$  are the degree of freedom for the linear regression and deviation terms, respectively, and  $\alpha$  is the level of significance taken as 0.05. The regressed  $\hat{y}_i = 94.667 - 2.681x_i$  is provided for your convenience.

2). What are the possible reasons leading to the rejection of the  $H_0$  hypothesis?

8. 【Central-4 MA】【27 $\frac{5}{8}$ : 12, 9, 3, 3】

A small factory has made profit from its sale of products in the past four years (1999 to 2002). Estimate the seasonal effects from the following quarterly data  $x_i$ ,  $i = 1$  to 4, in million dollars, using the method of central-4 moving average:

Year	Quarter			
	Q1	Q2	Q3	Q4
1999	68	70	66	57
2000	65	67	65	55
2001	64	65	63	53
2002	62	63	61	50

- 1). First calculate the resultant time series  $A_{4,2}$  using the central 4-moving average to smooth the quarterly data, then their corresponding residuals,  $R_i = x_i - A_{4,2}$ , the overall quarterly residuals,  $s_1$  to  $s_4$ , and the seasonally-adjusted values  $y_i = x_i - s_i$ .
- 2). Plot (sketch on a scaled graph on your answer sheet) the seasonally-adjusted values  $y_i$  against time  $t$  (16 quarters in the years 1999 to 2002) on the same figure for  $x_i$  and  $A_{4,2}$ .
- 3). Observe the variations in the quarterly profits and 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 2003.

1. What is the purpose of Calculus? Describe the contents that you have studied in the college? (10%)
2. Evaluate the following limit values (20%)
  - (a)  $\lim_{x \rightarrow 0} \frac{\sin(ax)}{\sin(bx)} = ?$  (5%)
  - (b)  $\lim_{x \rightarrow 0} x^x = ?$  (5%)
  - (c)  $\lim_{x \rightarrow 0} (x \sin(1/x)) = ?$  (5%)
  - (d)  $\lim_{x \rightarrow 2} \frac{3x-5}{x-2} = ?$  (5%)
3. Evaluate the following derivatives (20%)
  - (a)  $\frac{d}{dx}(e^{-3x} \sin(x)) = ?$  (5%)
  - (b)  $\frac{d}{dx}(\sin^{-1}(x^2)) = ?$  (5%)
  - (c)  $\frac{d}{dx}(1+x)^{2x} = ?$  (5%)
  - (d)  $\frac{d}{dx} \int_{\sqrt{x}}^{x^2-3x} \tan(t) dt = ?$  (5%)
4. Evaluate the following integrals (20%)
  - (a)  $\int \frac{x^2}{(x^3-2)^2} dx = ?$  (5%)
  - (b)  $\int 3^{3-x} dx = ?$  (5%)
  - (c)  $\int_0^{+\infty} x e^{-2x} dx = ?$  (5%)
  - (d)  $\int_0^3 (x-2)^{-1} dx = ?$  (5%)

5. An environmental study of a certain suburban community suggests that the average daily level of carbon monoxide concentration in the air is described by the formula

$$C(p) = \sqrt{0.5p^2 + 17}$$

Parts per million when the population is  $p$  thousand. It is estimated that  $t$  years from now, the population of the community will be

$$p(t) = 3.1 + 0.1t^2$$

What will the change rate of carbon monoxide concentration be after 3 years from now? (15%)

6. A quarter circular plate with radius 3m is shown in the figure. Use integral method to find its area, and find the Centroid  $(\bar{X}, \bar{Y})$  of the plate. (15%)

