1、【Ordinary Differential Equations】20%

(a) Differential equations arise in many engineering applications. Please NAME the possible engineering application for each of the following differential equations:

(1). $m y'' + k y = 0$

(2). $EI y'' = f(x)$

(b) Find a general solution for the following second-order differential equation:

$y'' + \omega_o^2 y = \cos \omega t$, $y(0) = y_0$, $y'(0) = v_0$, and $\omega^2 \neq \omega_o^2$

2、【Partial differential equation】20%

(a). Linear partial differential equations, $Au_{xx} + 2Bu_{xy} + Cu_{yy} = F(x, y, u, u_x, u_y)$ can be classified into three types, depending on the condition of $B^2 - 4AC$.

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 type.

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

3、【Linear integral in a complex plane】10%

Find the integral of $1/z$ around a unit circle C given by :

$z(t) = \cos t + i \sin t = e^{it}$ $(0 \leq t < 2\pi)$

4、【Solution by undetermined coefficients e】10%

Solve the following linear differential equation by solution of undetermined coefficients :

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

5、【Laplace transform】10%

Solve the following linear differential equation by Laplace transform :

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

6、【Fourier analysis】10%

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

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

7、【Method of least squares, Vector analysis and Linear algebra】20%

(a). A straight line $y = a + bx$ is to be fitted through a set of n points $(x_1, y_1), ..., (x_n, y_n)$. Find the mathematical expression for the constant coefficients a and b.

(b). [Vector quantity in three-dimensional form] Express in vector form the moment of a force F about a line L through an arbitrary point p with a distance r from the force.

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

1. A free falling object in the water usually encounters external forces which may decompose into surface forces and body forces. In empirical expression, the surface forces have been simplified as drag forces and buoyant force. Please use above terms to describe the motion equation of the object. (25%)
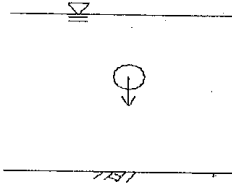
2. A gate, shown in Fig. (a), is installed in a channel suddenly pulling up a small gap, shown in Fig. (b). How to determine the forces on the gate in both situations and indicates which one has larger forces on the gate. Assume that the channel friction effect is negligible. (25%)

(a)　　　　　　(b)　10cm

gate width=1m

2m　　　2m
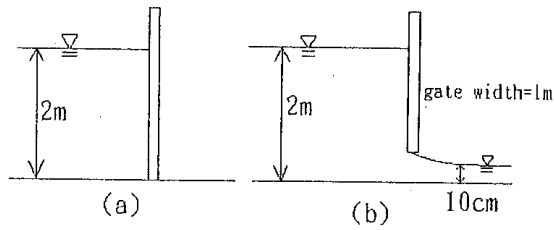
3. According to your opinion and observation for the public construction works, after the struck of 921 Earthquake, have any improvements been done? If yes, what are the evident cases? If no, what may be the major problems? (25%)

4. The construction of a suspending type cable-car across the Kaohsiung Harbor has been discussed. Without considering the impact of the environment, in your opinion in terms of the safety of this type of construction, do you approve for this construction and why? (25%)

一、今年 2004 年世界環境日的主題為「海洋的生與死」，試就此一議題，敘述地球海洋環境污染及海岸環境破壞的情況(海洋之死)，以及如何保護海洋及海岸的環境，以永續海洋資源(海洋之生)。(50%)

二、近來我國所推動的政府再造工程中，有意將原先的「環境保護署」升格成為「環境資源部」？試問為何需將「環境」與「資源」等事務放在同一部會內統籌經管？可以舉例說明之。(25%)

三、最近衛生署所公佈的牛奶食品衛生檢驗報告中指出，某些乳製產品的品牌，其「戴歐辛」含量超過標準值。請問什麼是「戴歐辛」？其來源為何？又從什麼管道跑到乳製品中？有辦法減低其在食品中出現的濃度嗎？？

(25%)

1. Please explain 'surfactant' and discuss (a) the mechanism of micelle formation and (b) the solubilization power of micelles. (15%)

2. Please discuss the mechanism of separation of compounds by use of (a) liquid chromatography (b) electrodialysis (10%)

3. Please explain K_{ow} and K_{oc}. Please discuss their significance in environmental science. (15%)

4. Please explain Langmuir adsorption isotherm and discuss its applications. (10%)

5. Please discuss the applications of activity coefficient. (5%)

6. Please discuss the effect of pH on the toxicity of ammonia nitrogen. (5%)

7. Please write down (with explanation) a first order rate expression for a chemical reaction. (5%)

8. Please explain: (15 %)
   (a) Nernst equation (b) buffer intensity (c) break point chlorination

9. During a field survey, please suggest a methodology in detail to obtain a vertical profile of dissolved oxygen concentrations (in good quality) in a lake. (8%)

10. Please write down the chemical formula for the following chemicals (12%)
    (a) 1-octanol
    (b) dioxins
    (c) hexachlorobenzene
    (d) tetra-n-butyltin (TBT)

(1) (40%) The scientific approach to the analysis and solution of managerial problems involves:
   (a) collection of information,
   (b) specific definition of the problem,
   (c) selecting alternative courses of action,
   (d) testing the selected alternatives,
   (e) selecting the best alternative(s),
   (f) implementation.
   Please state extensively each of six steps in your **master thesis** research.

(2) (30%) There are two broad classes of mathematical models: **deterministic** and **stochastic**. Please describe under what situations will each type of models be most suitable for?

(3) (30%) It is the current trend to explore the sustainable development in many popular issues. For example, the "integrated coastal zone management" (ICZM) has been promoted in the European Union (EU) for the purpose of sustainable costal zone management. To fulfill the goal of sustainable development, many aspects of researches, such as social-economics, environment, ecology, need to be considered simultaneously in a modeling process due to their interactive relation. Please state your opinion about how to integrate or combine different types of models as a whole system for the assessment of sustainable development.

一、　台灣需不需要成立海洋事務部？國土的主管機關與海洋事務主管機關有何關係或如何分割權責？你認為「海洋事務（Marine Affairs）」的範疇包括哪些重要議題？(40%)

二、　海岸地區填海造地或興建人工結構物有何影響？環評有何關鍵？（30%）

三、請就所知，討論這篇報導（部分內容）的相關議題：（30%）

花蓮縣曼波魚季五月中旬剛落幕，短短二十八天，擁入十二萬觀光人次，比去年同期成長三倍，總產值約四億元，共吃掉近千尾約十萬公斤的曼波魚。

曼波魚（原名翻車魚）原本是上不了檯面的魚，經濟價值極低，但因為發現富含膠原蛋白，花蓮縣府和業者合作，在兩年前打出「曼波魚季」，並開發出一○一種吃法，成為饕客新寵。

曼波魚一隻母魚一次最多可產三億顆卵。但主辦今年曼波魚季的花蓮縣政府農業局卻承受不少壓力。農業局長杜麗華不平地表示，為何「連總統都能替黑鮪魚代言」，花蓮縣政府不過是推動曼波魚季稍有成果，就得面對外界非理性的批判，「這樣對我們弱勢的漁民並不公平」。

杜麗華指出，去年首次推廣曼波魚季時，公約就已經啟動，限制漁民不能捕捉三十公斤以下的小魚。且漁民多採定置捕捉法，「等曼波魚游上來曬太陽時」進入定置漁網，漁獲量也視天氣、氣流而定，「這是最被動、最生態的捕捉方式」。

杜麗華指出，今年曼波魚季已推出生態教育活動，鯉魚潭的水產培育所設置曼波主題館，介紹曼波魚的生態，提供觸摸體驗，約有十二萬人次參觀；另有「與曼波共舞」的潛水活動，帶遊客到定置網潛水，近距離觀察曼波魚。

外界質疑花蓮縣政府在推廣曼波魚季之前，並未深入了解其生態便大量捕捉。杜麗華對此提出反駁，她說，國內的曼波魚研究本來就很少，農業局今年已行文水試所，提出協助進行研究的要求。

她並指，曼波魚季明年還會再辦，但將擴大生態、海洋文化體驗活動，以創造雙贏。

【2004-06-07/聯合報/A9版/社會話題】

第一部份：數學公式／簡要說明題　【55 分】

1. 【Terminology】【10 分】

   In Statistical Analysis, mean $\bar{x}$ and regressed value $\hat{x}_i$ are calculated from a set of 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】【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.

3. 【ANOVA】【10 分】

   1). What does the acronym *ANOVA* stand for?

   2). What are the main objectives of the *ANOVA*?

4. 【Normal distribution】【15 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.
   (a). Indicate the position of the *mean, median* and *mode* on a biased distribution curve.
   (c). Define the *skewness* (偏態) and *kurtosis* (峰態) mathematically using $x_i, \bar{x}$, s and N.
   (d). 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 $-3\sigma \le z_i \le +3\sigma$, where σ is the standard deviation of the population. What is the value of total coverage with the range $-2\sigma \le z_i \le +2\sigma$?

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.

第二部份：計算題　　【45 分】

6. 【Test of hypothesis and t-distribution】【15 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
   $$H_0: \mu_1 \le 18\%$$
   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 $t = \dfrac{\bar{x} - \mu_o}{s\sqrt{1/n}}$ 】

7. 【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.

1、解釋名詞：(4%×10=40%)

(1) Coriolis Force (2) aphotic zone (3) continental slope (4) Ekman spiral
(5) knot (6) lagoon (7) plankton bloom (8) salt wedge (9) sverdrup (sv) (10) trace element

2、何謂 Biological amplification？請舉例說明。(10%)

3、何謂板塊理論（Plate Tectonics）？台灣東部的海岸山脈是如何形成的呢？
(20%)

4、下圖為 6/8/2004 早上 CONSON 颱風的警報單，請預測墾丁東部海岸（標示 X 處）於 6/9/2004 早上 8 時的風向、風漂流流向、及波浪的方向。(30%)