科目：**工程數學【海工所甲組】**

1. 論述多變數函數之 Taylor 級數展開式及其應用。30%

2. 利用分離變數法(the method of separation variables)

   論述三度空間中在卡氏直角座標與圓柱座標下之

   $\nabla^2 \phi = 0$ 的通解。40%

3. 論述 Poisson integral formula 及其應用。30%

1. During the 921 Chi-Chi earthquake Taiwan suffered disastrous damages including mostly the civil buildings, bridges, schools and transportation structures. According to your understanding on structural dynamics could you give some engineering reasons about damages on the reinforced concrete structure? (10%)

2. For the dynamic response of structure what are the essential properties of the structure (and why) and what is the most important interaction between the response and the exerting forces? What can be done if this interaction happens during the dynamic responses? (15%)

3. Please briefly describe the meanings and contents of weighted-integral and weak formulation in finite element formulation. (10%)

4. The governing differential equation for a homogeneous aquifer of unit depth, with flow in the (x,y) plane, is given by   (15%)

$$-\partial(a\partial\phi/\partial x)/\partial x - \partial(a\partial\phi/\partial y)/\partial y = f$$

where a is the coefficients of permeability (unit m day^{-1}), ϕ is the piezometric head (in m), measured from a reference level (usually the bottom of the aquifer), and f is the rate of pumping (in m^3 day^{-1} m^{-1}). Here we consider a specified problem, that two pumps are located at (1000,670) and (1900,900), puimping at rates Q1=1200 m^3 day^{-1} m^{-1} and Q2=2400 m^3 day^{-1} m^{-1}, respectively. Please compute, at least the ideal, the global forces for pump 1, located inside element 19. That is, the nodal forces at nodes 12, 18 and 13. The general sketch and mesh arrangement are shown in Fig. 1. The coordinates for the nodes and pump are also given in Fig. 1c.

Noted that: the linear interpolation functions for the triangular element is $\psi_i = (\alpha_i + \beta_i x + \gamma_i y)/(2A_e)$, (i =1,2,3), where A_e is the area of the triangle, and α_i, β_i, and γ_i are constants and defined as $\alpha_i = x_j y_k - x_k y_j$, $\beta_i = y_j - y_k$, and $\gamma_i = - (x_j - x_k)$ (i≠j≠k; and i, j and k permute in a natural order).
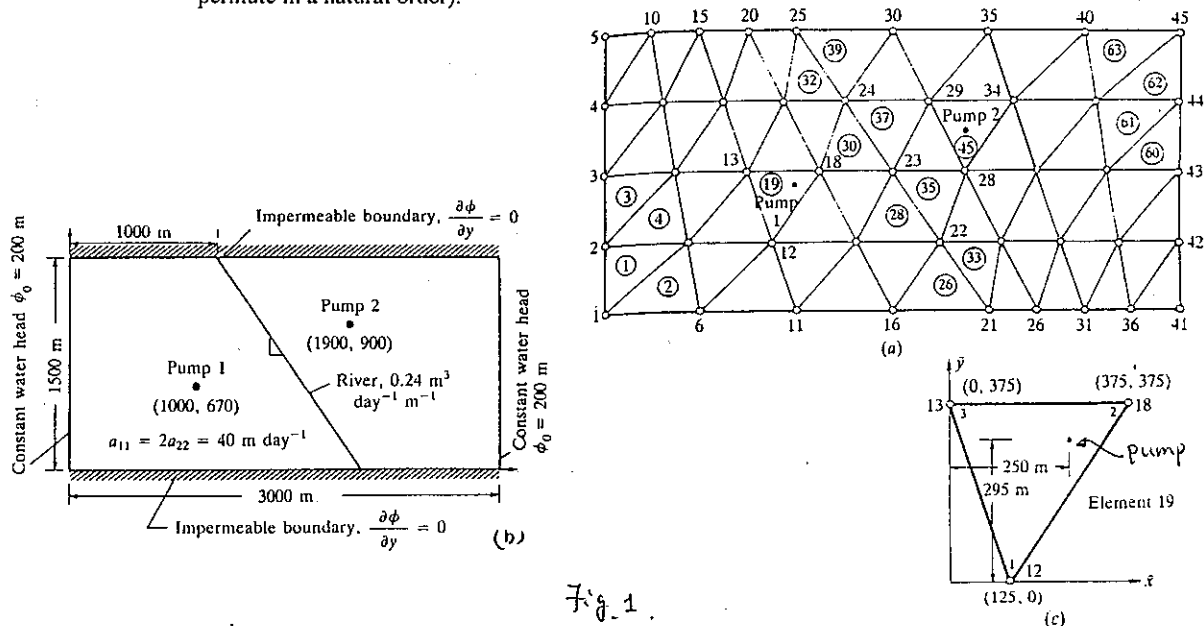

Fig. 1.

流體力學部分：

1. 論述描述流體運動之方式及其對應的三大守衡方程式 25%

   質量、動量、能量

2. 試說明 Reynolds Transport Theorem 25%

$$\frac{DB_{sys}}{Dt} = \frac{\partial}{\partial t}\int_{cv} b\rho d\forall + \int_{cs} b\rho \vec{V} \bullet d\vec{A}$$

如何應用在 1. conservation of mass — (continuity eqn.)

2. momentum eqn.

3. moment — of — momentum eqn.

4. energy eqn.

一、請說明海洋中陸源性物質的來源及其傳輸至海洋的過程機制與宿命變化，並分析其對海洋環境及生態的影響。(33%)

二、台灣目前關心的海洋污染問題主要為哪些？請分別說明其重要性、形成機制與影響。(33%)

三、何謂有害廢棄物？分為那幾大類？試述有害廢棄物處理與處置之工程技術。根據我國之「廢棄物清理法」中之規定，該如何有效管理有害廢棄物？而目前所面臨的問題又有那些？該如何去解決？(34%)

一、試分析比較採用生化需氧量(BOD)、化學需氧量(COD)及總有機碳(TOC)等分析方法，檢測海水中有機物含量之優缺點。針對這些缺點，該如何改進。(20%)

二、何謂膠凝作用(coagulation)？膠凝劑之種類包含那些？這些膠凝劑能產生膠凝作用之原理為何。如何將此一化學處理方法應用於水及廢水處理上？(20%)

三、在優養化(eutrophication)之湖泊中，於白天檢驗其水質，常發現其 pH 值會高達 10 至 11，試說明其原因。(可以化學平衡方程式輔助說明之) (10%)

四、環境分析時，金屬含量與有機毒物如多氯聯苯分別可使用哪些儀器（請各舉兩種以上）定量，請大致描述這些儀器之偵測原理與適用範圍，並請比較優缺點。 (25%)

五、請解釋(1)金屬(2)有機毒物如多氯聯苯，在自然水體中吸附到顆粒上的機制與決定因子分別為何？請就水體、污染物、與顆粒特性探討。 (25%)

[註]: 請儘量答題，總分為 100 分。

1. 海岸地區有那些特性使得在建立海岸地理資訊系統(Coastal GIS)時，與一般陸上地理資訊系統之建立大異其趣，試說明之。　（20分）

2. 試說明一般地理資訊系統之分析功能有那些，請儘量陳述。　（20分）

3. 試說明地理資訊系統與電腦輔助繪圖軟體(Computer Aided Drafting, CAD)結合資料庫管理系統(Database Management System)之間的差異為何？　（20分）

4. 許多地理資訊系統在資料建立時，並不需要先將向量資料建立空間位相關係，一直到某些時刻才建立空間位相關係，為什麼？另有一些地理資訊系統並未建立空間位相關係，為什麼？　（20分）

5. 今有一水庫管理局欲建立一個水庫管理地理資訊系統，若委託你來規劃，試述其規劃步驟，並請詳細說明可以包含之空間分析功能？　若發現水庫管理局留存有十年以上水深資料，且每年皆由不同的測量公司施測，請詳細說明應如何使用這些資料。　（20分）

一、 It is known that 84% of all college professors have doctoral degrees. What is the probability that a given college professor does not have a doctoral degree and what is the probability that of 10 college professors all have doctoral degrees. (10%)

二、 $P(A|B) = 0.2$， $P(A) = 0.2$，且 $P(B) = 0.4$，則 $P(A \cup B) = ?$ (10%)

三、 設 $E(X) = 8$， $E(X^2) = 100$， $E(Y) = 10$， $E(Y^2) = 200$， $E(XY) = 40$，則： $Var(X - Y) = \underline{\quad(1)\quad}$， $\gamma_{X,y} = \underline{\quad(2)\quad}$， $Var(2X+Y) = \underline{\quad(3)\quad}$， $Var(2X+Y+3a-2b+c) = \underline{\quad(4)\quad}$。 (16%)

四、 The daily production rates of a sample of workers in a factory before and after a training program are shown below. (15%)

Worker	Before	After
1	6	9
2	10	12
3	9	10
4	8	11
5	7	9

At 95% confidence, test to see if the training program was effective. That is, did the training program actually increase the production rates? (Yes or No, justify your answer) $t_{0.95,4} = 2.132$

五、 If we want to determine the average mechanical aptitude of a large group of workers, how large a random sample will we need to be able to assert with probability 0.95 that the sample mean will not differ from the true mean by more than 2.5 points? Assume that it is known from past experience that $\sigma = 10$. $Z_{0.025} = 1.96$ (14%)

六、 A multiple regression is estimated and the results are as follows: (15%)

$$Y = 1.05 + 2.0186x_1 - 1.1764x_2 \quad adj-R^2 = 0.77$$
$$\quad\quad (0.4) \quad\quad (1.023) \quad\quad (3.440)$$

Where the numbers in parenthesis are the estimated standard errors. Suppose you are not satisfied with the level of the adj-R^2(adjusted-R^2). Which variable you drop will result in a higher level of adj-R^2 ?

七、 計算題：某生利用迴歸分析得到下列結果，請填寫報表 (20%)
中①～⑩諸項。

The regression equation is

$$Y = -1.41 + 0.0235X_1 + 0.00486X_2$$

Predictor	Coef	Stdev	t-ratio
Constant	-1.4053	0.4848	
X_1	0.023467	0.008666	
X_2	①	0.001077	②

S=0.1298 $R-sq =$ ③ $R-sq(adj) =$ ④

Analysis of Variance

Source	DF	SS	MS	F
Regression	⑤	1.76209	⑧	⑩
Error	⑥	⑦	⑨	
Total	9	1.88000		

1. What factor of factors generally limit the productivity of polar, temperate, and tropical ocean regions? (15%)

2. Describe the three types of plate boundaries (of plate tectonics). (15%)

3. What is the Sound Channel? How does it be formed? (15%)

4. What are the main sources of the dissolved oxygen in sea water? What are the primary agents to consume the dissolved oxygen in the upper and lower ocean? (15%)

5. What is the *El Niño*? How does it affect the global weather? (20%)

6. Draw force-balance diagrams to explain how the wind blowing on the sea surface can drive sea water to flow in an Ekman Spiral pattern. Note that the Ekman Spiral can be developed conceptually by the force balance *layer by layer* from the surface down to below. (20%)