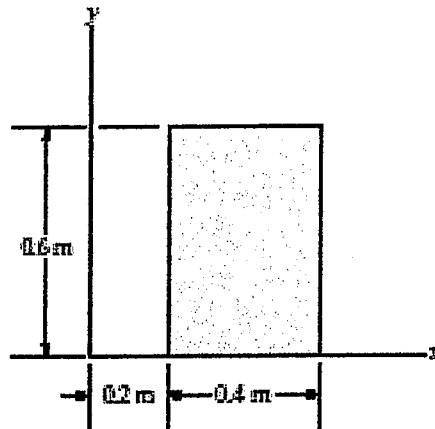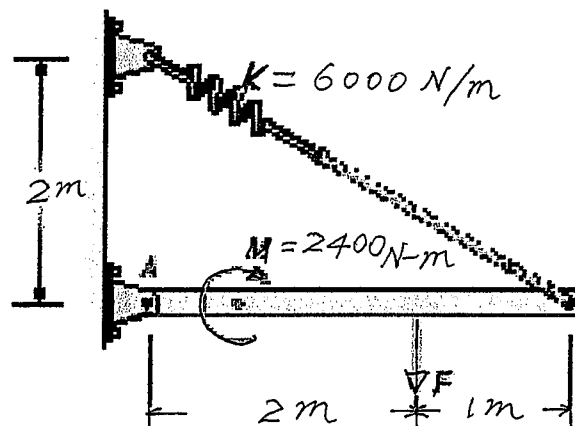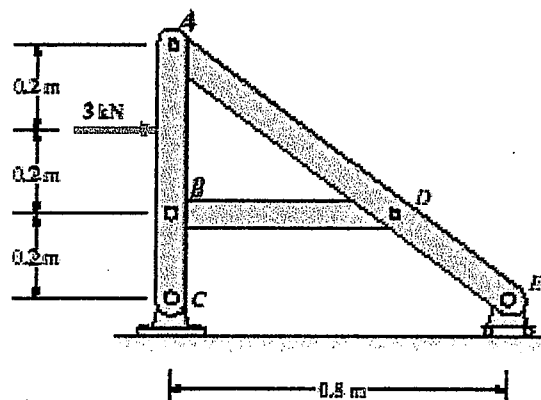科目：工程力學【海工系碩士班甲組選考】　∨

1. Please find the moments of inertia for I_x and I_y for the block in Fig.1. (10%)

2. For a system in equilibrium shown in Fig.2, where the beam is horizontal, determine the force F and the reactions at A. (20%)

3. For a system shown in Fig.3, please determine the reactions on Member ABC. (20%)

4. Please answer the following terms: (15%)

　　(1) Prismatic bar

　　(2) Pure torsion

　　(3) Simply support beam

　　(4) Perfect plastic material

　　(5) Saint Vennant principle

5. Please draw the shear force and bending moment diagrams of the beam shown in Fig. P2.　(20%)

6. A steel bar is fractured as shown in Figure 3. Please explain the failure mechanism of the bar. (please give your theoretical reason of the cause of the failure). (15%)
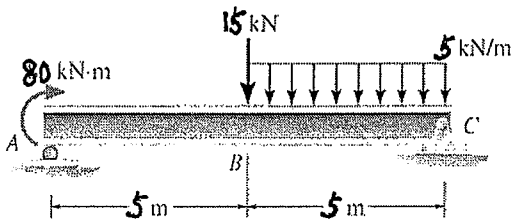

Fig. P2
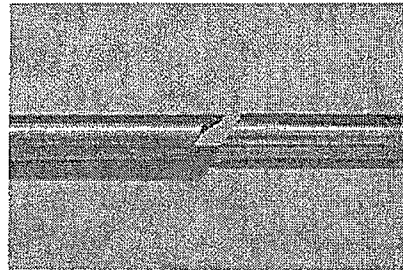
Fig. 3

20% 1. A 60-cm-wide belt moves as shown in Figure. Calculate the horsepower requirement assuming a linear velocity profile in the $10°C$ water.

($\mu = 1.308 \times 10^{-3}$ N·s/m²; 1 hp=746w)
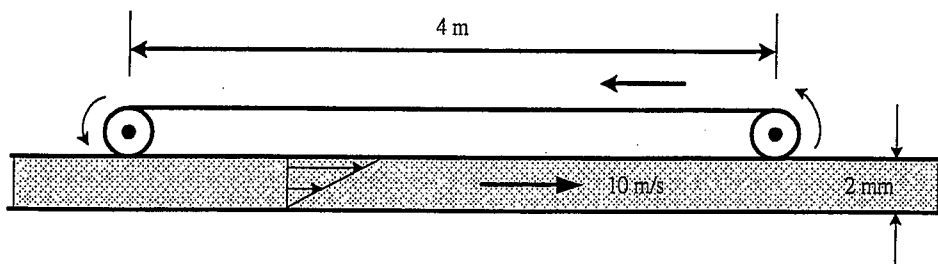
20% 2. Calculate the force F necessary to hold the 4-m-wide gate in the position shown in Figure. Neglect the weight of the gate .
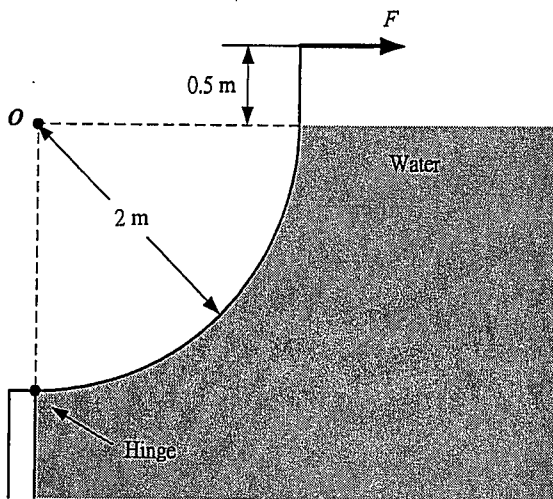
15% 3. The pressure distribution over the base of a concrete (S=2.4) dam varies linearly, as shown in Figure producing an uplift force. Will the dam topple over?
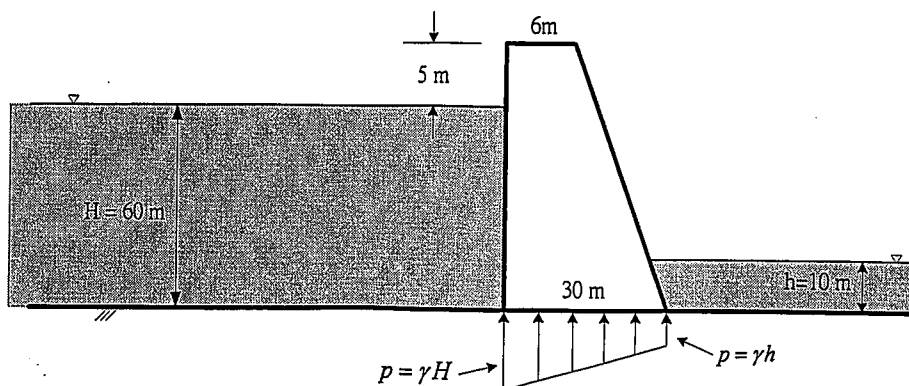
4. The velocity field given by $V = 2x\, \mathbf{i} - yt\, \mathbf{j}\ m/s$, where x and y are in meters and t is in seconds. Find the equation of the streamline passing through (2,-1) and a unit vector normal to the streamline at (2,-1) at t = 4 s

5. The velocity potential a flow is
$$\phi = 10x - 5\ln(x^2 + y^2)$$
(a) Show that this satisfies $\nabla^2\phi = 0$
(b) Find the stream function $\psi(x,y)$.

6. Water is pumped from a large lake into an irrigation canal of rectangular cross section 3 m wide, producing the flow situation shown in Figure. Calculate the required pump power assuming ideal flow. (The velocity behind the dam is negligible.)
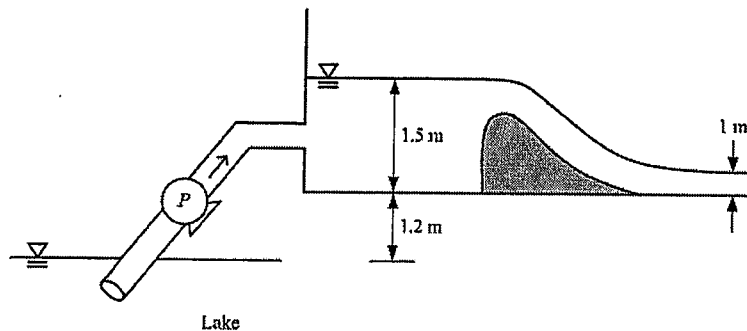
1. 【Ordinary Differential Equations】30%

   (a) Solve the IVP $\cos(x-y)y' - \sin(x-y) - \cos(x-y) = 0$, $y(0) = 7\pi/6$ (10%)

   (b) Solve $x^2 y'' + 5xy' - 12y = \ln(x)$ (10%)

   (c) Solve the IVP by Laplace transform $y'' - 2y' - 3y = \begin{cases} 0 & if\ 0 \le t < 4 \\ 12 & if\ t \ge 4 \end{cases}$, $y(0) = 1$, $y'(0) = 0$ (10%)

2. 【Linear Algebra】10%

   $$\text{Matrix } \mathbf{A} = \begin{bmatrix} 3i & 0 & 0 \\ -1 & 0 & i \\ 0 & -i & 0 \end{bmatrix}.$$

   (a) Determine whether the matrix $\mathbf{A}$ is hermitian, skew-hermitian, unitary, or none of these. (2%)

   (b) Find the eigenvalues and an associated eigenvector for each eigenvalue. (4%)

   (c) Determine if the matrix $\mathbf{A}$ is diagonalizable? If it can be diagonalizable, generate a matrix that diagonalizes it. (4%)

3. 【Vector Calculus】10%

   Find the flux of $\mathbf{F} = xz\,\mathbf{i} - y\,\mathbf{k}$ across the part of the sphere $x^2 + y^2 + z^2 = 4$ lying above the plane $z = 1$.

4. 【Partial differential equation】10%
   Partial differential equations are classified as elliptic, parabolic or hyperbolic. Please give one example in (a) name and (b) mathematical form for each type of the equations mentioned above.

5. 【Partial differential equation】20%

   Find ALL 3 possible solutions for the PDE $\dfrac{\partial^2 u(x,y)}{\partial x^2} = \dfrac{\partial u(x,y)}{\partial y}$ by the method of separation of variables.

   [Suggestion: You may leave the solutions including the separation constants, because the boundary conditions for $u(x,y)$ are not given for this specific question.]

6. 【Fourier analysis】20%

Find the Fourier series solution for a periodic function given by:

$$f(t) = \begin{cases} 0, & -\pi < t < 0, \\ t, & 0 < t < \pi, \end{cases}$$

with period 2π, as shown in figure on the right-hand-side →.

Please show your answer in:

(a) series approximation, and (10%)

(b) expand the series to the third term of $n=3$. (10%)
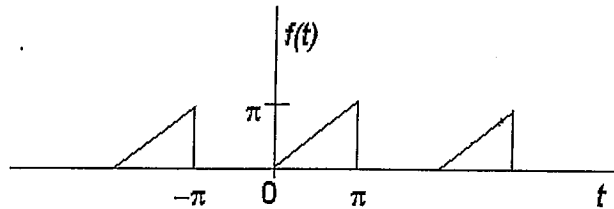
科目：基礎環境科學【海工系碩士班乙組】　√

一、解釋名詞：(40%，每小題4分)

1. biogeochemical cycles
2. coevolution
3. ecotone
4. carrying capacity
5. fertility rate
6. biodiversity
7. sustainability
8. hazardous wastes
9. hypoxic zone
10. photochemical smog

二、問答題：(60%)

1. Why both poverty (貧窮) and affluence (富裕) have harmful environmental effects? (12%)

2. What is natural capital? How do we protect natural capital? (12%)

3. What are the causes of global warming? How can we do to solve this environmental problem?(12%)

4. Please, describe the differences among conservation, preservation, and restoration for ecosystems. (12%)

5. Please, compare environmental technology (engineering), cleaner technology, and ecotechnology (ecological engineering) used to solve environmental problems. (12%)

科目：環境微生物學與環境化學【海工系碩士班乙組】 √

1. 何謂格蘭氏染色(Gram Stain)?格蘭氏染色的原理為何？試簡述格蘭氏染色的實驗步驟。(10%)

2. 試述微生物參與廢水處理的種類有那些？其所扮演的功能角色為何？試分述之。(10%)

3. 試述硫桿菌屬(*Thiobacillus*)中，有關 *Thiobacillus thiooxidant*、*Thiobacillus ferroxidant* 及 *Thiobacillus denitrificant* 等三種菌種，依代謝作用分類。各屬於何類形的微生物(例如像好氧異營性微生物)？試分別寫出其主要的代謝異化作用的生化反應式。(10%)

4. 分析 BOD 與 COD 在環境工程上各有何意義？並請說明其差異性。 (8%)

5. 以 Winkler Method 測溶氧時，假設 $0.025N \ S_2O_3^{-2}$ 溶液被用來滴定 150 ml 水樣，結果總共滴了 3ml 達到滴定終點，請估計水樣之溶氧濃度（以 mg/l 為單位） （8%）

6. 試將下列官能基(functional group)列出: alcohols, acid, ethers, aromatics (8%)

7. 請畫出一條代表性 Langmuir adsorption isotherm (請定義 x 與 y 軸)，並說明此 isotherm 所具有之特徵與特徵之物理意義 (8%)

8. Given a redox reaction:

$$I_2 + 2S_2O_3^{2-} = S_4O_6^{2-} + 2I^-$$

The standard free energy of formation ΔG^o_f Kcal/mole:

$I_2 = 4.0$; $S_2O_3^{2-} = -130$; $S_4O_6^{2-} = -250$; $I^- = -12$

Please calculate E^0 for the above redox reaction.
(8%)

9. 某有機污染物在水環境中裂解(degradation)動力學屬一級反應(first order reaction)，在一次意外洩漏到一水環境中 50 天後，發現該污染物濃度剩下原來的 40%，請列式子並估計需要多少天該污染物濃度會剩下原來的 20%。（6%）

10. 何謂土壤的陽離子交換能力(Cation Exchange Capacity, CEC)? 通常以何單位表示? 有何重要性?（6%）

11. 水溶液含 0.001N 的 NaOH，其 pH 值? 含 0.005N 的 H_2SO_4，其 pH 值?（6%）

12. 何謂亨利定律？請說明如何運用此定律估計水中溶氧濃度。（6%）

13. 何謂 disinfection by-products (DBPs)? 主要含哪類化合物? 水中的 DBPs 如何除掉? (6%)

1. 目前的環境危機包含了那些議題？造成這些議題的基本原因為何？人們面臨這些環境問題，該如何解決？（25%）

2. 中山大學宿舍區的學生一直受到居住於台灣獼猴的騷擾，而台灣獼猴又是列為台灣保育的生物物種之一。而日本亦有黑熊入侵民宅，干擾人類生活起居及生命安全的問題。請問面臨這個保育與人類發展衝突的議題，該如何解決？（25%）

3. 澳洲大堡礁國家公園目前正在向全球招募管理員，台灣亦有人前去應徵。請問如果你是那位應徵者，該如何推銷你自己有能力擔任該項工作？陳述中包括大堡礁目前所面臨的環境問題，以及該如何進行保護及保育的工作。（25%）

4. 環境問題的解決最終仍需依靠一些工程技術去解決，在各類工程技術中，請問環境工程技術、清潔生產技術，以及生態工程技術，在保護環境的應用上，有何差異性？試述之。(25%)

1. 請說明下列段落所談內容，並說明 cloud computing 之特點與結構。(25 分)

Cloud computing is Internet ("cloud") based development and use of computer technology ("computing"). It is a style of computing in which dynamically scalable and often virtualised resources are provided as a service over the Internet. Users need not have knowledge of, expertise in, or control over the technology infrastructure "in the cloud" that supports them.

The concept incorporates infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) as well as Web 2.0 and other recent (ca. 2007-2009) technology trends which have the common theme of reliance on the Internet for satisfying the computing needs of the users. Examples of SaaS vendors include Salesforce.com and Google Apps which provide common business applications online that are accessed from a web browser, while the software and data are stored on the servers.

Cloud architecture, the systems architecture of the software systems involved in the delivery of *cloud computing*, comprises hardware and software designed by a *cloud architect* who typically works for a *cloud integrator*. It typically involves multiple *cloud components* communicating with each other over application programming interfaces, usually web services. This closely resembles the Unix philosophy of having multiple programs doing one thing well and working together over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts. *Cloud architecture* extends to the client, where web browsers and/or software applications access *cloud applications*. *Cloud storage architecture* is loosely coupled, where metadata operations are centralized enabling the data nodes to scale into the hundreds, each independently delivering data to applications or users.

As customers generally do not own the infrastructure, they merely access or rent, they can avoid capital expenditure and consume resources as a service, paying instead for what they use. Many cloud-computing offerings have adopted the utility computing model, which is analogous to how traditional utilities like electricity are consumed, while others are billed on a subscription basis. Sharing "perishable and intangible" computing power among multiple tenants can improve utilization rates, as servers are not left idle, which can reduce costs significantly while increasing the speed of application development. A side effect of this approach is that "computer capacity rises dramatically" as customers do not have to engineer for peak loads. Adoption has been enabled by "increased high-speed bandwidth" which makes it possible to receive the same response times from centralized infrastructure at other sites.

2. 請說明下列段落所談內容，並說明 grid computing 特點及發展潛力。(25 分)

Grid computing (or the use of a computational grid) is the application of several computers to a single problem at the same time – usually to a scientific or technical problem that requires a great number of computer processing cycles or access to large amounts of data. According to John

科目：計算機概論【海工系碩士班丙組選考】

Patrick, formerly IBM's vice president for Internet strategies, "the next big thing will be grid computing."

Grid computing depends on software to divide and apportion pieces of a program among several computers, sometimes up to many thousands. Grid computing can also be thought of as distributed and large-scale cluster computing, as well as a form of network-distributed parallel processing. It can be small -- confined to a network of computer workstations within a corporation, for example -- or it can be a large, public collaboration across many companies or networks.

It is a form of distributed computing whereby a "super and virtual computer" is composed of a cluster of networked, loosely coupled computers, acting in concert to perform very large tasks. This technology has been applied to computationally intensive scientific, mathematical, and academic problems through volunteer computing, and it is used in commercial enterprises for such diverse applications as drug discovery, economic forecasting, seismic analysis, and back-office data processing in support of e-commerce and Web services.

What distinguishes grid computing from conventional cluster computing systems is that grids tend to be more loosely coupled, heterogeneous, and geographically dispersed. Also, while a computing grid may be dedicated to a specialized application, it is often constructed with the aid of general-purpose grid software libraries and middleware.

Grids can be categorized with a three stage model of departmental grids, enterprise grids and global grids. These correspond to a firm initially utilising resources within a single group i.e. an engineering department connecting desktop machines, clusters and equipment. This progresses to enterprise grids where nontechnical staff's computing resources can be used for cycle-stealing and storage. A global grid is a connection of enterprise and departmental grids that can be used in a commercial or collaborative manner.

3. 當你嘗試在 amazon.com 買書時，你會發現網頁會提供你許多建議，例如："Frequently Bought Together"、"Customers Who Bought This Item Also Bought"、"Books on Related Topics"、"Customers Viewing This Page May Be Interested in These Sponsored Links"、"What Do Customers Ultimately Buy After Viewing This Item?"等，請說明製作這些項目可能之基本原理及作法？ (20 分)

4. 在資料庫中常須建立 metadata，請問何謂 metadata？其作用為何? (10 分)

5. 請說明 bubble sort 作法(5 分)？並以 Fortran、Basic 或 C 程式語言撰寫一程式來執行之。(15 分)

科目：線性代數【海工系碩士班丙組選考】 ∨

1. (15%) Given **A** and **B** are square matrices of the same size:

   (a) (10%) Prove that in general $(\mathbf{A}+\mathbf{B})^2 \neq \mathbf{A}^2 + 2\mathbf{AB} + \mathbf{B}^2$.

   (b) (5%) Under what condition does equality hold?

2. (20%) About skew-symmetric matrix.
   (a) (5%) Give an example of a skew-symmetric matrix.
   (b) (5%) Prove that a skew-symmetric matrix is a square matrix having diagonal elements zero.
   (c) (5%) Prove that the sum of two skew-symmetric matrices of the same size is also a skew-symmetric matrix.
   (d) (5%) Prove that the scalar multiple of a skew-symmetric matrix is also skew-symmetric.

3. (15%) Prove that $T:\mathbf{R}^3 \to \mathbf{R}^3$ defined by $T(x,y,z)=(0,y,0)$ is a linear transformation. This transformation is also called a *projection*. Why is this term appropriate?

4. (15%) Given 4 matrices $\begin{bmatrix} 4 & 1 \\ 7 & 10 \end{bmatrix}, \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}, \begin{bmatrix} 3 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} -1 & -1 \\ 2 & 3 \end{bmatrix}$, determine whether the first matrix is a linear combination of the matrices that follow. If your answer is yes, show the linear combination.

5. (15%) Consider the vector $\mathbf{v} = \begin{bmatrix} 3 & 2 & 1 \end{bmatrix}$ in $\mathbf{R}^3$. Let W be the subspace of $\mathbf{R}^3$ consisting of all vector of form $\begin{bmatrix} a & b & a+b \end{bmatrix}$. Decompose **v** into the sum of a vector that lies in W and a vector orthogonal to W.

6. (20%) Two car rental companies, A and B, are competing for customers at certain airports. A study has been made of customer satisfaction with these two companies. The results are expressed by the following matrix **R**. The first column of **R** implies that 75% of those currently using rental company A are satisfied and intend to use A next time, while 25% of those using rental company A are dissatisfied and plan to use B next time. There is a similar interpretation to the second column of **R**. You may modify the matrix R to obtain a transition matrix **P** for a Markov process that describes the car rental patterns. If the current trends continue, how will the rental distribution eventually settle? (Express the distribution in percentage that use companies A and B)

$$\begin{array}{c} \text{(from)} \\ \begin{array}{cc} \text{A} & \text{B} \end{array} \quad \text{(to)} \\ \mathbf{R} = \begin{bmatrix} 75\% & 20\% \\ 25\% & 80\% \end{bmatrix} \begin{array}{c} \text{A} \\ \text{B} \end{array} \end{array}$$

科目：統計學【海工系碩士班丙組選考】 √

第一部份：數學公式/簡要說明題　【60分】

1. （**10%**）【假設與檢定】
   (a) 請以標題方式列舉統計學中"假設與檢定"的五大步驟。
   (b) 請簡扼說明"假設與檢定"中設立"假設"的三大基本原則。

2. （**10%**）【假設與檢定】
   某貿易商由美國進口加州蘋果，合約規定每個蘋果的重量應大於 600 公克，否則可退貨。今由某一貨櫃中隨機抽樣 50 個蘋果，求得樣本平均重量為 565 公克、標準偏差為 30 公克。
   (a) 請建立虛無假設（H_0）、對立假設（H_1）及應以何種方式（雙尾、左尾或右尾）進行檢定？
   (b) 請說明應以何種統計方法估計後，再推論該貿易商是否可以提出退貨的要求？

3. （**10%**）【平均數檢定之信賴區間】
   由隨機抽樣的樣本特徵可推論母體特徵。在假定某一 "顯著水準"α值後，需依樣本之大小及標準偏差α之已知或未知，選擇一種特定的機率分佈函數，以估計樣本平均數之信賴區間。請問：
   (a) 樣本大小之常用值 N=？ 個
   (b) 大樣本時，樣本平均數之信賴區間數學表示式為何？
   (c) 小樣本時，樣本平均數之信賴區間數學表示式為何？

4. （**20%**）【常態分佈】
   隨機抽樣 x_i（ i = 1 to N），在大樣本數 N 時，樣本個值出現之機率可能符合常態分佈 $N(\bar{x}, \sigma)$；$\bar{x}$ 為樣本平均數，σ 為樣本標準偏差。請簡扼表示或回答下列問題：
   (a) 繪圖標示在右偏分佈情況下 *mean*、*median* 及 *mode* 的相關位置；.
   (b) 以 x_i、$\bar{x}$、σ 及 N 表示 skewness（偏態）及 kurtosis（峰態）；
   (c) 機率密度函數（probability density function）$p(x)$ 的數學式；
   (d) 在以 $z_i = (x_i - \bar{x})/\sigma$ 標準化後的對稱常態分佈圖 $N(0, 1)$ 上：請問在 $-\sigma \leq z_i \leq +\sigma$、$-2\sigma \leq z_i \leq +2\sigma$ 及 $-3\sigma \leq z_i \leq +3\sigma$ 之三個區間，累積機率各為多少%？

5. （**10%**）【變異數及相關係數】
   由兩組觀測值 x_i 及 y_i（ i = 1 to N）：
   (a) 何謂 "共變異數" *covariance* C_{xy}？又其數學式為何？.
   (b) 何謂 "相關係數" *correlation coefficient* ρ_{xy}？又其數學式為何？

第二部份：計算題　【40分】

6. （**20%**）【平均數差值的信賴區間】（陳、陳，2003）
   某職業補習班宣稱其打字課程學員在修課後可增進打字速度，否則可要求退費。今隨機抽取 6 位打字員，得知在修課前後之打字速度（字/分鐘）：

打字員：	1	2	3	4	5	6	平均數
修課前：	57.8	60.5	60.2	57.4	55.9	58.3	μ_1
修課後：	61.7	60.3	64.4	58.5	56.2	62.8	μ_2

   假設打字速度屬常態分佈，修課前後之母體平均速度各為 μ_1 及 μ_2；求（$\mu_1 - \mu_2$）在顯著水準α=95% 之信賴區間。
   【 提示：先求修課前後之打字速度 $d = \mu_1 - \mu_2$，再運用 t-表－t：見附表】

7. （**20%**）【單變異數檢定】
   某電腦製造商宣稱某產品至少可保用三年。今隨機抽取使用者 10 名，得知其使用年數各別為【3.5, 3.1, 3.4, 3.7, 3.2, 3.8, 2.9, 3.2, 3.1, 2.1】。若該製造商宣稱該產品使用年數之變異數為 σ=0.2，假定顯著水準α=95%，請檢定該製造商之宣稱是否屬實？
   【提示：先建立假設與檢定，再以基本統計量與 χ^2 表估計之 Critical Region 相比－χ^2：見附表】

TABLE　Critical Values of t for ν Degrees of Freedom and Selected Levels of Significance

Number of Degrees of Freedom, ν	Significance Level, α (%)					
	10	5	2.5	1	0.5	0.1
1	3.078	6.314	12.706	31.821	63.657	318.310
2	1.886	2.920	4.303	6.965	9.925	22.327
3	1.638	2.353	3.182	4.541	5.841	10.215
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.893
6	1.440	1.943	2.447	3.143	3.707	5.208
7	1.415	1.895	2.365	2.998	3.499	4.785
8	1.397	1.860	2.306	2.896	3.355	4.501
9	1.383	1.833	2.262	2.821	3.250	4.297
10	1.372	1.812	2.228	2.764	3.169	4.144

TABLE　Critical Values of χ^2 for ν Degrees of Freedom and Selected Levels of Significance

Number of Degrees of Freedom, ν	Significance Level, α (%)				
	20	10	5	2.5	1
1	1.64	2.71	3.84	5.02	6.63
2	3.22	4.61	5.99	7.38	9.21
3	4.64	6.25	7.81	9.35	11.34
4	5.99	7.78	9.49	11.14	13.28
5	7.29	9.24	11.07	12.83	15.09
6	8.56	10.64	12.59	14.45	16.81
7	9.80	12.02	14.07	16.01	18.48
8	11.03	13.36	15.51	17.53	20.09
9	12.24	14.68	16.92	19.02	21.67
10	13.44	15.99	18.31	20.48	23.21
11	14.63	17.28	19.68	21.92	24.72
12	15.81	18.55	21.03	23.34	26.22
13	16.98	19.81	22.36	24.74	27.69
14	18.15	21.06	23.68	26.12	29.14
15	19.31	22.31	25.00	27.49	30.58

Part 1: Differentiation and limits (60%)

1. (20%) Find the limit for each of the following expressions:

   (a) $\lim\limits_{x\to 1}\dfrac{5x^3+3x^2-8}{3x^4-5x^2+2x}$;　　(b) $\lim\limits_{x\to 0}\dfrac{\sqrt{x}}{\sin 3\sqrt{x}}$;

   (c) $\lim\limits_{x\to\infty} x^{1/x}$;　　(d) $\lim\limits_{x\to\infty}(\sqrt{x^2+x}-x)$;

2. (10%) Find the derivative for each of the given function with respect to x :

   (a) $f(x)=\sqrt{x^2+\sqrt{x^2+1}}$;　(b) $f(x)=\tan(x^2-1)$;

3. (10%) (a) Find the derivative of $f.g/(f+g)$, where f, g are differentiable functions;

   (b) Given $x^3y^3+x^2y^2+xy=2$, find dy/dx by implicit differentiation.

4. (10%) Let x and y satisfy $x^2-\sqrt{xy}+y^2=6$ and assume that y is a function of x in the neighborhood of (2, 2). Determine the value of $y'(2)$.

5. (10%) Verify that $y(x,t)=\dfrac{1}{2}[(x-ct)^2+(x+ct)^2]$ is a solution to the wave equation,

   $$\frac{\partial^2 y}{\partial t^2}=c^2\frac{\partial^2 y}{\partial x^2}.$$

Part 2: Integration (40%)

6. (10%) Evaluate $\displaystyle\int_1^4(\sqrt{x}+\frac{1}{x^2})\,dx$

7. (10%) Evaluate $\displaystyle\int\frac{\cos 2x}{\sin^3 2x}\,dx$

8. (10%) Evaluate $\displaystyle\int_0^1 x\tan^{-1}x\,dx$

9. (10%) Evaluate $\displaystyle\frac{d}{dx}\int_{2x}^{x^2}u(1+u^2)^3\,du$