國立雲林技術學院
八十四學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：工程數學

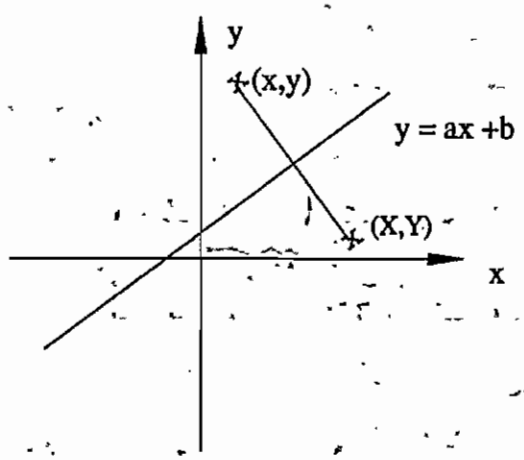
1. (a) Solve the initial value problem **[10%]**

$$\frac{d^2y}{dt^2}+2\frac{dy}{dt}+2y=\delta(t-3)\quad,\quad y(0)=\frac{dy(0)}{dt}=0$$

(b) Find two linearly independent solutions of the equation **[15%]**

$$x^2\frac{d^2y}{dx^2}+x^2\frac{dy}{dx}-xy=0\qquad 0<x<\infty$$

2. Given a line y = ax + b, a ≠ 0, shown below



Point (X,Y) is reflected by the line y = ax +b from (x, y).

(1). Find the transformation from (x, y) to (X, Y). (5%)

(2) Is this transformation linear ? Please show it. (5%)

(3) If it is not, choose appropriate b, make it linear. Then, define its transformation matrix. (2%)

(4) Find the eigenvalues of above matrix. (4%)

(5) Find the corresponding eigenvectors for each eigenvalue. (4%)

(6) Show the geometric meaning of these eigenvalues and eigenvectors. (5%)

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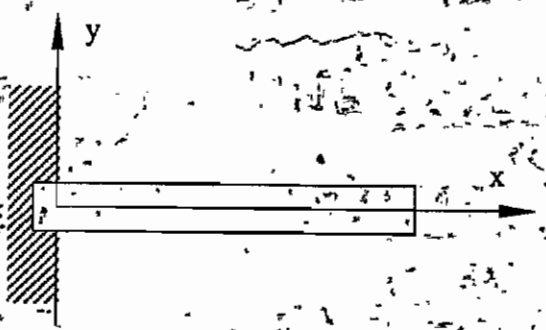
3. A free-bending-vibration problem of a beam can be modeled by a partial differential equation shown as

$$\frac{\partial^2 y}{\partial t^2} + c^2 \frac{\partial^4 y}{\partial x^4} = 0$$

(1) How many initial conditions and how many boundary conditions are needed to solve this problem ? (10%)
(Hint, show your answer by separating variables.)

(2)



If a beam is clamped at one end and free at the other end, please decide its boundary conditions and describe their **physical meaning.** (15%)

4. (a) Calculate all values of $(2-i)^{-2/3}$, $i = \sqrt{-1}$ **[10%]**

(b) Evaluate $\int_{-\infty}^{\infty} \frac{\sin x}{x(1+x^2)} dx$ **[15%]**

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1）一般設計專案（Engineering Design project）不只是工程的演算和繪圖的工作，雖是從專案開始就應用到工程的專業知識在設計上从找出(a) 3% 最佳的設計（含效率及經濟性利益），但工程的應用只是專案工作的一部份，其他還包括(b) 3% 製程的安排，(c) 3% 成本的預估及控制，(d) 3% 工作進度的掌控，(e) 3% 設計結果的評估，(f) 3% 結案報告（Final Report）及(g) 3% 口頭報告（Oral presentation）等，請您从實務經驗說明上述各項(a)至(g)的重要性，並(h) 9% 說明結案報告應包括的項目和內容。

2）在設計一個石化工廠的油料輸送管的管徑大小，經过計算後，所需的管徑大小，常常是介於兩種商用口徑的中間，例如設計後所需的管徑是1$\frac{1}{2}$"但是管商只有2"和1$\frac{1}{2}$"的管子，若是要求管商提供你所需的管徑，不是價格高出數倍，就是無法提供。因此只有從可買到的管件中去挑大一些，或是小一些的管子。(a) 10% 但挑大管子或小管子都各有優缺点，請說明之。(b) 10% 但整体的考量上，於管路接裝時，挑大管徑或小管徑管子，那者較佳？

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科目：專業實務

3) 請詳述

① 您碩士階段之學習目標。

② 具体的研究計畫。

③ 具体說明服務單位之發展與您研究計畫之関連性。

④ 試由設計、製造、控制、熱流四領域，淺談未來工業技術之發展趨勢。

4) 請合理解釋下列現象

① 战鬥机爬昇仰角过大，造成失速。

② 長髮女郎，騎見擋風罩之机車向前疾馳时，髮往前飄。

③ 过稀、过濃的瓦斯均無法產生氣爆。

⑤ 微波炉可加熱牛乳，卻無法加熱玻璃器皿。

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科目：動力學

1. 一飛機之起落架及其兩種不同之動坐標系統如圖(一)所示，當飛機起飛後，該起落架繞 O_1O_2 軸旋轉而收至機腹內。於收回動作剛開始之瞬間，起落架仍然位於如圖所示的垂直位置，而此時輪胎的自轉速率為 80 (rad/sec)，並以 2 (rad/sec²) 之速率減速，若起落架以等速率 0.5 (rad/sec) 收至機腹內，試求 P 點之速度與加速度？

2. 如圖(二)所示，為求得一馬達轉子的平衡性，吾人將該馬達安置於一簡支樑的中心，馬達之總重為 W = mg (公斤力，kilogram force)，且由於 W 之作用使得樑所產生的靜態位移為 0.098 (cm)。吾人以 We 來衡量馬達轉子的平衡性，亦即將整個馬達視為一個質點，e 為此質點(質心)到馬達幾何中心的距離。設馬達之轉速為 Ω (rpm)，強迫垂直振動之振幅為 X (cm)，試導出一計算偏心距 e 大小的公式。

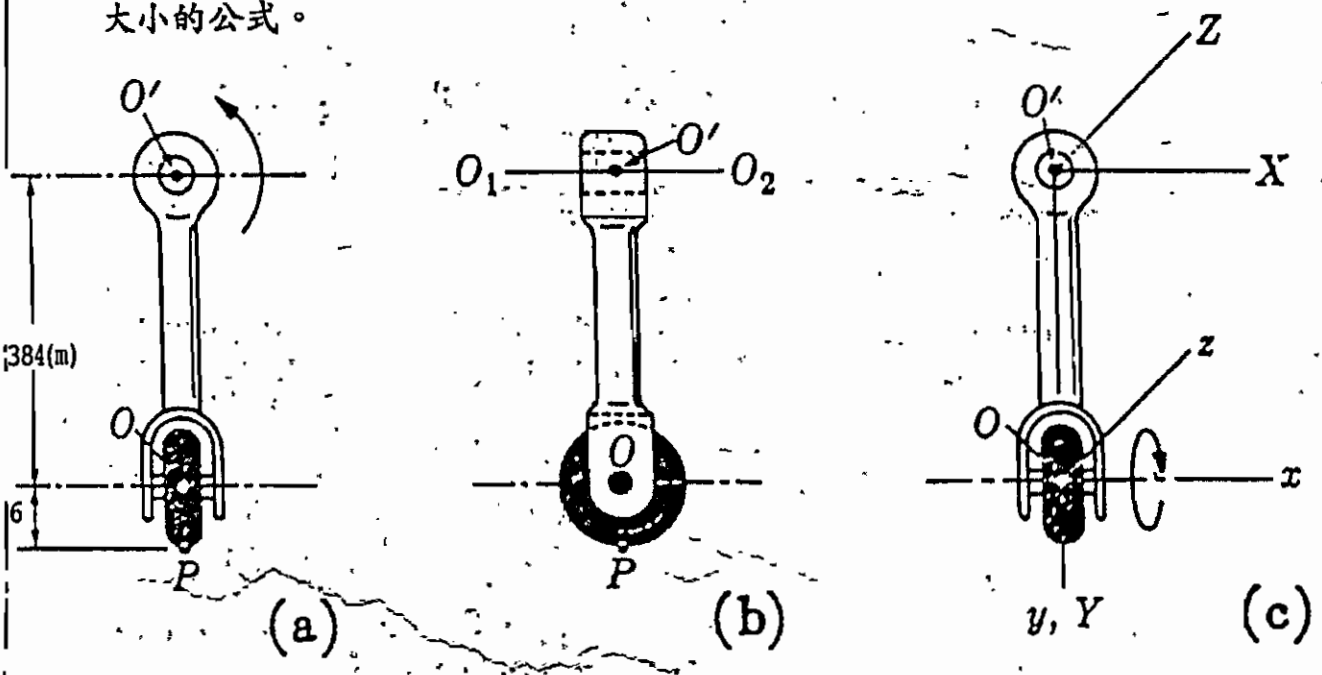

圖 (一)

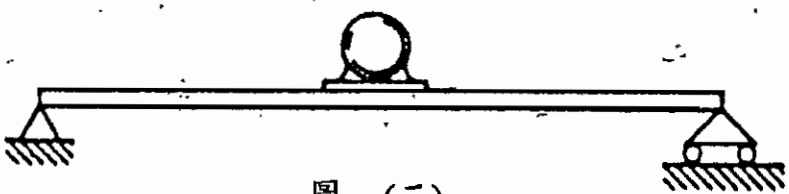

圖 (二)

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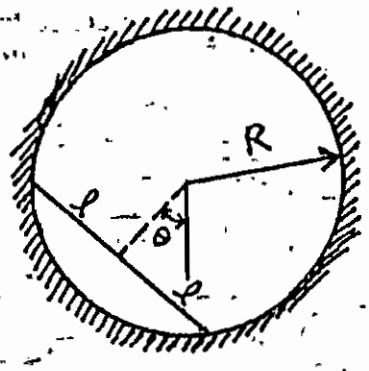
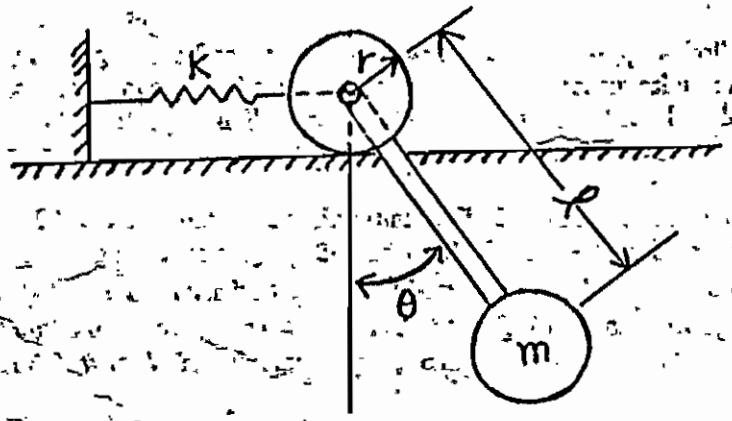
3.(25%)



A rigid rod slides back and forth on the smooth walls of a circular cylindrical surface. Derive the governing equation for θ and indicate each step clearly.

4.(25%)



A rigid rod is rigidly attached to the axle which in turn is attached to a linear spring. The wheels roll without slip as the pendulum swings back and forth. Only the ball on the end of the pendulum has appreciable mass, and it may be considered a particle. The spring force is zero when θ is zero. Derive the governing equation for θ.

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電子與資訊工程技術研究所
科目：電子電路

1.(40%) The switch in the circuit shown in Fig.1 has been in position a for a long time. At t=0 the switch is moved to position b. What is the (a) initial value of v_c? (b) final value of v_c? (c) time constant of the circuit when the switch is in position b? (d) expression for $v_c(t)$ when $t \geq 0$?

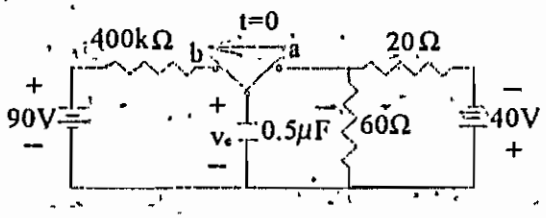

Fig.1

2.(20%) An RLC series-connected circuit is shown in Fig.2. The steady-state expression for the source voltage v_s is 750cos(5000t+30°). (a) Construct the phasor-domain equivalent circuit. (b) Calculate the steady-state current i by the phasor method.

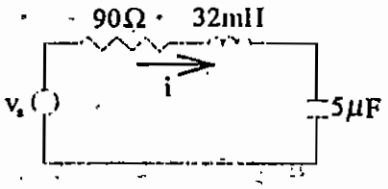

Fig.2

3. (10%) An op amp having a low-frequency gain of 1000 and a single-pole rolloff at 10000 rad/s is connected in a negative-feedback network having a transmission k and a two-pole rolloff at 10000 rad/s. Find the value of k above which the closed-loop amplifier becomes unstable.

4.(30%) A two-stage CMOS amplifier resembling that in Fig.3 is found to have a slew rate of 5V/μs and an unit-gain frequency f_t=2MHz. (a) If the first-stage bias current (2I) is 50μA; what value of C_c must be used? (b) If devices with 1-V threshold are used, what gate-to-source bias voltage is used in the input stage? (c) For a process for which $\mu_n C_{ox}$=20μA/V², what W/L ratio applies for the input-stage devices?

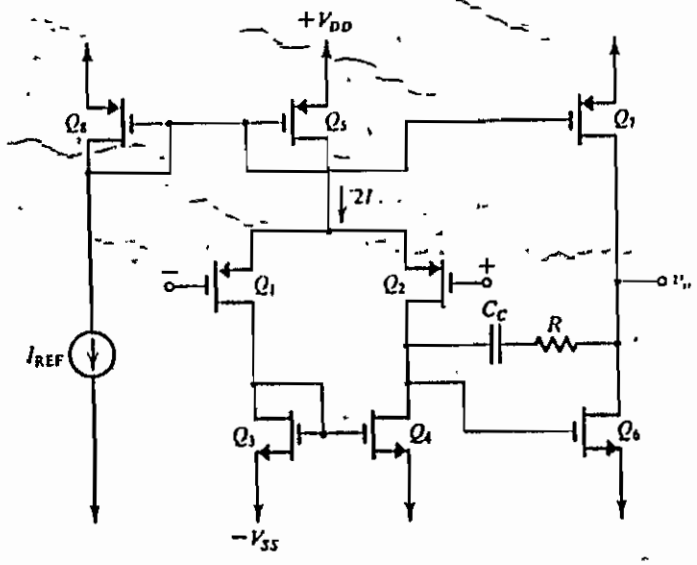

Fig. 3

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(a) In metal casting, what are the functions of (i) raiser; and (ii) runner extension? To design them, what will you consider? (10%)

(b) In powder metallurgy, (i) what is the purpose of impregnation? (ii) what is atomization? (5%)

(c) Compare the advantage and limitation of (i) gas tungsten-arc welding ; and (ii) submerged-arc welding. (10%)

(a) Describe the procedure you will follow to do a straight turning operations. Please write down your answer step by step clearly. (10%)

(b) Describe the standardized code of grinding wheel designation, and state the principles to choose a grinding wheel. What will you do before using a grinding wheel? (15%)

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3. (a) Name at least four problems in hardening. (10%)
(b) How to eliminate the problems mentioned above? (10%)

4. Please indicate two methods for making the conical sheet metal part as shown in Figure 1. What are the advantages and disadvantages of the two methods? (10%)

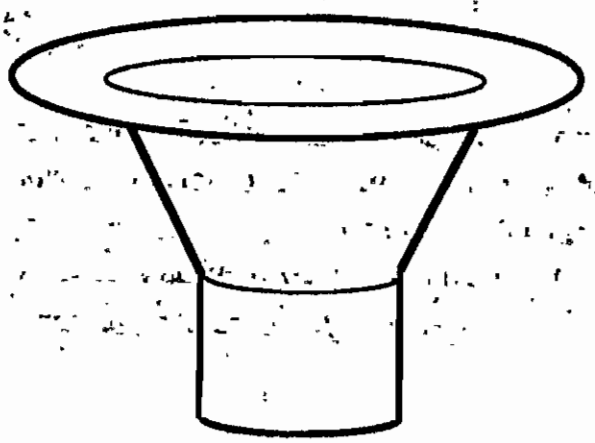

Fig. 1

5. Describe the following surface hardening processes:
(a) Induction hardening, (4%)
(b) High-frequency resistance hardening, (3%)
(c) Flame hardening. (3%)

6. Please describe the following nontraditional machining processes:
(a) Hydrodynamic Machining, (HDM) (3%)
(b) Ultrasonic Machining (USM). (3%)
(c) Electrical Discharge Wire Cutting (EDWC). (4%)

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所別：機械工程技術研究所
科目：熱力學

C_p= 1.05 kJ/kg°c　　R=8.314 kJ/kgmol/°K

1. A piston-cylinder machine contains nitrogen initially at 2.0 bars, 107°C, and 0.300 m^3. The piston moves with negligible friction until the pressure rises to 5.0 bars. The process is described by the equation V=0.40 - 0.050P, where V is in m^3 and P is in bars. Determine (a) the final temperature, in °C, (b) the mass present, in kg, (c) the work done, in N.m, and (d) the heat transfer, in kJ. (25%)

2. An air compressor handling 300 m^3/min increases the pressure from 1.0 to 2.3 bars, and heat is removed at the rate of 1700 kJ/min. The inlet temperature and area are 17°C and 280 cm^2, respectively, and these values for the exit are 137°C and 200 cm^2. Find (a) the inlet and exit velocities, in m/s, (b) the required power input, in kW and (c) the entropy change. (25%)

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3. Derive an expression of ω for a fluid obeying the vapor-pressure equation

$$\ln P^{sat} = A - B/T$$

For the same fluid, show how ω is related to the slope of the reduced-vapor-pressure curve plotted with $\log_{10}P_r$ and $1/T_r$ as coordinates.

4. Air at a pressure of 100 psia and a temperature of 70 °F enters a horizontal steam-jacketed pipe with a velocity of 100 ft/sec. Measurements at the exit end of the pipe show that the air is heated to 390 °F and that the pressure is 97 psia. What percentage of the pressure drop in the pipe can be attributed to fluid friction? Assume that the air behaves as an ideal gas.

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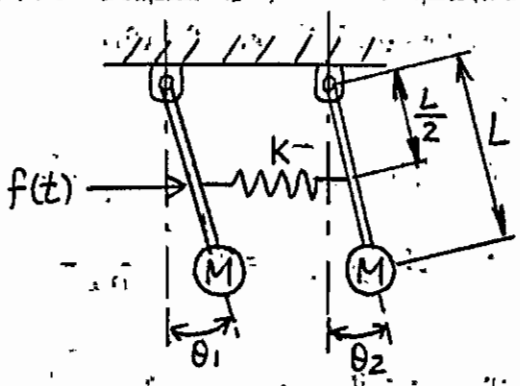
科目：自動控制

1. 下圖所示乃一雙擺錘（pendulums）之機械系統結構。



假設連結桿（bar）本身並無質量，試求：

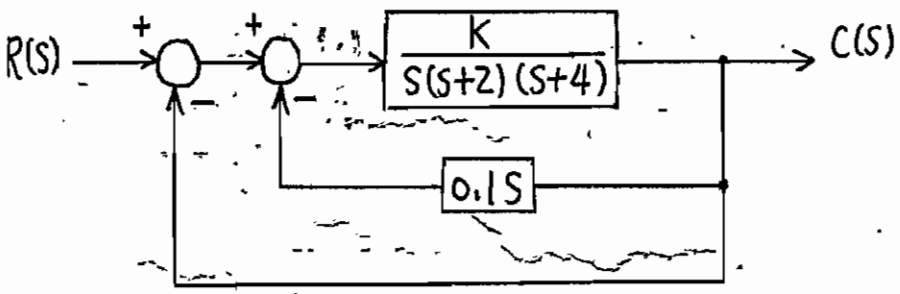
(a) 雙擺錘之運動方程式。(6%)

(b) 假設擺角 θ_1 及 θ_2 均很小，請利用線性化（linearization）技巧將 (a) 中所得之運動方程式加以化簡。(6%)

(c) 繪出系統訊號流程圖（signal-flow diagram）。(6%)

(d) 轉移函數（transfer function）$T(s)=\theta_1(s)/F(s)=?$ (7%)

2. 有一控制系統之方塊圖如下：



(a) 請利用根軌跡法（root locus method）技巧估算當閉迴路系統之主要極點（dominate poles）之阻尼比爲 0.5 時之 K 值。(10%)

(b) 請導出當系統 K 值爲 (a) 中所估算之值時，系統之響應 $c(t)=?$ (15%)

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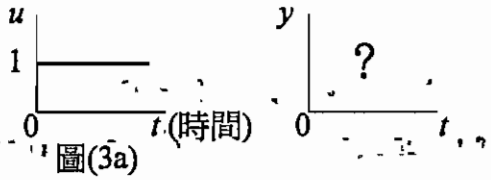
3. 下列系統中，依照所給定的輸入函數 $u(t)$，大略畫出輸出變數 y 對時間的變化曲線圖(time response)。注意曲線的形狀，並標出啓始斜率及穩態位置。

(A) $\frac{Y(s)}{U(s)}=\frac{3}{s+5}$，$y(0)=0$，$u(t)$如圖(3a)。(6%)

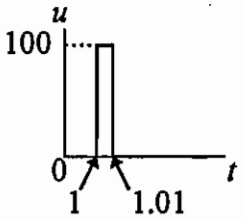


圖(3a)

(B) $\frac{Y(s)}{U(s)}=\frac{3}{s^2+s+9}$，$y(0)=0$，$\dot{y}(0)=0$，$u(t)$如圖(3a)。(6%)

(C) $\frac{Y(s)}{U(s)}=\frac{3}{s^2+6s+9}$，$y(0)=2$，$\dot{y}(0)=1$，$u(t)=0$. (6%)

(D) $\begin{cases}\dot{x}_1(t)=x_2\\ \dot{x}_2(t)=-4x_1+u(t)\\ y(t)=x_1\end{cases}$，$x_1(0)=x_2(0)=0$，$u(t)$如圖(3b)。(7%)

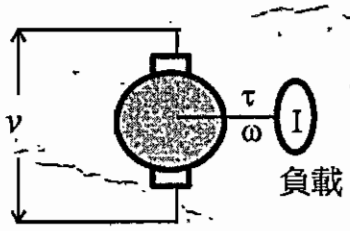


圖(3b)

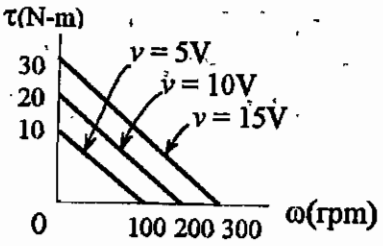
4. 下圖(4a)爲一直流馬達控制系統，已知輸入電壓 v(單位伏特)與輸出轉矩 τ 及角速度 ω 的關係曲線如圖(4b)所示。

(A) 若圖(4a)中的負載的轉動慣量 I = 10kg-m^2，求馬達旋轉角度θ (單位 rad)與輸入電壓 v 間的 transfer function ($\frac{\Theta(s)}{V(s)}$)。(不計馬達轉子的轉動慣量。) (12 %)

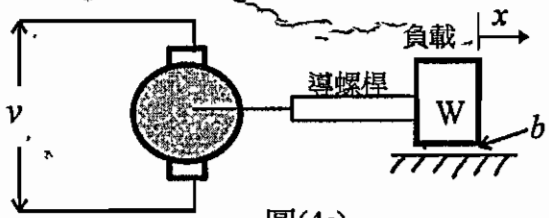
(B) 圖(4c)中馬達轉軸連接導螺桿驅動一負載， W = 5kg ，已知若馬達轉軸旋轉一圈則負載前進 1cm ，且負載與滑道間的滑動阻泥常數 b=1N/(m/sec)，求負載位移 x 與輸入電壓 v 間的 transfer function ($\frac{X(s)}{V(s)}$)。(不計導螺桿的慣量) (13 %)



圖(4a)



圖(4b)



圖(4c)

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The truss pictured in Fig. A is subjected to loads P and 2P at joint A. All members of the truss are assumed to be prismatic and to have the same axial rigidity EA. Calculate the horizontal and vertical displacements of joint B of the truss using the unit-load method. (25%)

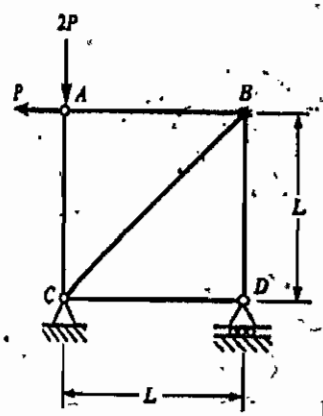

Fig A

A cantilever beam of length L and rectangular cross section (width b, height h) carries a concentrated load P at the free end (see Fig. B). The stress-strain curve of the material in tension is represented by the equation $\sigma = B\sqrt{\varepsilon}$, where B is a constant; the curve has the same shape in compression. Determine the strain energy and complementary energy for this beam. (25%)

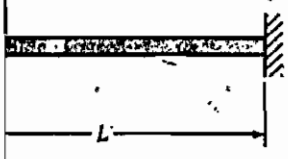

Fig B.

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八十四學年度研究所碩士班入學考試試題

所別：機械工程技術研究所
科目：材料力學

3 The total normal force uniformly distributed over edge AB of the plate of Fig. 3 is 67,500 N, and the total shear force is 54,000 N. For edge BC the normal and shear forces are 607,500 N and 135,000 N, respectively. Draw a view showing an element with the given state of stress and also draw the corresponding Mohr circle. Draw an element with sides parallel to the x- and y-axes and show the stresses acting on it.

(25%)

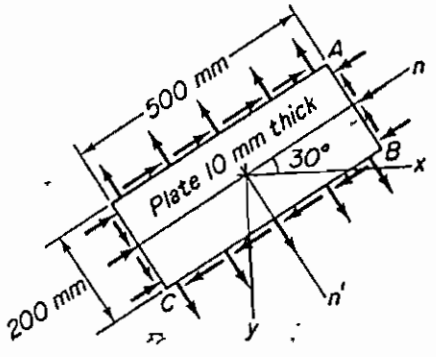

FIGURE 3

4 Find the force in each bar in Fig. 4 $E_1 = 2E_2$. The 2,300-kg mass can be considered rigid.

(25%)

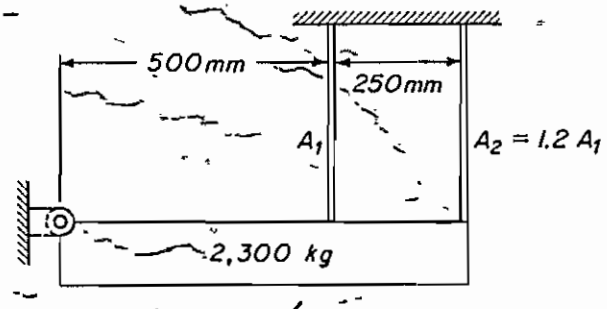

FIGURE 4

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[1] A ceiling fan consists of four blades of 0.8 m length and 0.1 m width which rotate at 200 rpm. Estimate the torque needed to overcome the friction on the blades if they act as flat plates. (25%)

[2] The capillary rise h of a liquid in a tube varies with tube diameter d, gravity g, fluid density ρ, surface tension γ, and the contact angle θ. (15%) (a) Find a dimensionless statement of this relation. (10%) (b)If h=3 cm in a given experiment, what will h be in a similar case if the diameter and surface tension are half as much, the density is twice as much, and the contact angle is the same?

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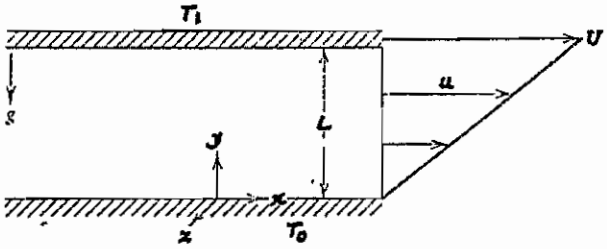
3. The simplified energy equation for Couette flow is

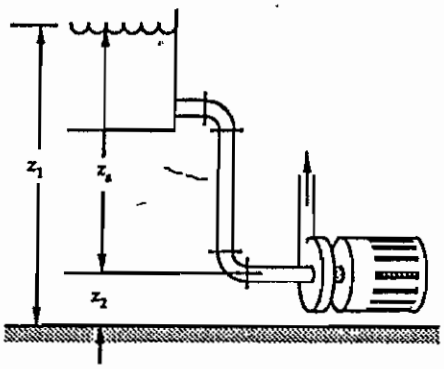
$$\frac{d^2T}{dy^2}+\frac{\mu}{k}\left(\frac{du}{dy}\right)^2$$



a) If both plate temperatures are equal, what is the maximum temperature occurs in the flow field ? and Where ? Also, Sketch the temperature distribution. (20%)

b) Show from the energy equation for Couette flow that the viscous dissipation rate is a uniformly distributed heat source at the value $\mu U^2/L^2$, regardless of the boundary condition imposed. (5%)

4. In order to avoid cavitation (孔蝕) in a hydraulic pump, the net positive suction head available ($NPSH_a$) must be greater than the net positive suction head required ($NPSH_r$). The $NPSH_a$ is defined as the difference between the absolute pressure head in the flow at the pump inlet and the liquid's vapor pressure head.



a) Now, the $NPSH_r$ for a particular pump operating at 1750 rpm on cold water is given as $H_r = H_0 + AQ^2$, where H_0 = 3 meter of water and A = 0.06 m/(m^3/min)^2. Assume the pipe system consists of a open reservoir, whose surface is 10m above the pump centerline, pipe of 0.15m diameter, and 90^o elbow. The total system losses can be expressed as $KV^2/2g$, where K=15. Calculate the maximum volume flow rate at which the pump can be operated without cavitation. (water density is 1000 kg/m^3, water vapor pressure at the temperature is 1.8kPa). (15%)

b) If the pump is operating under the maximum flow rate with the same condition as above, except the reservoir is now closed and underpressured, what should be done to keep the system free from cavitation? (the pressure in the reservoir is now 620 mmHg and the water vapor pressure is 830 Pa). (6%)

c) Plot the NPSH (including $NPSH_a$ and $NPSH_r$) versus flow rate curves, and show the point corresponding to the maximum flow rate. (4%)