國立雲林技術學院
八十五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. Use complex analysis to evaluate the following integrals:

(a) $$\int_0^{\pi} \frac{d\theta}{a + b\cos\theta}, \quad a > b > 0 \qquad [12\%]$$

(b) $$\int_0^{\pi} \frac{d\theta}{(a + b\cos\theta)^2}, \quad a > b > 0 \qquad [13\%]$$

2. (a) Give examples of the elliptic, parabolic, and hyperbolic partial differential equations (PDE's). Indicate at least one characteristic of the solutions of these PDE's respectively. [6%]

(b) Under what circumstances or conditions, can the method of separation of variables method be applied to solve a PDE? [6%]

(c) Use the method of separation of variations to solve the problem:

$$\frac{\partial^2 z}{\partial t^2} = a^2\left(\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2}\right)$$

in a domain D shown in Figure 1. The boundary conditions are
$z(0, y, t) = z(1, y, t) = z(x, 0, t) = z(x, 1, t) = 0$; $z(x, y, 0) = f(x, y)$ and
$|z(x, y, t)| < M$ (i.e., the absolute value of function z is bounded) [13%]

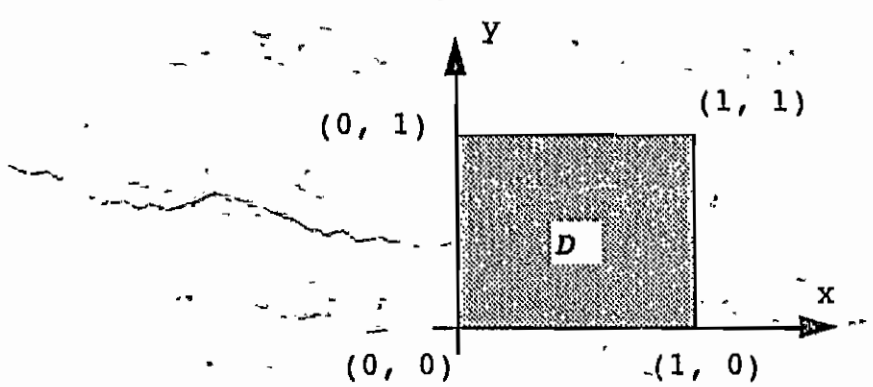

Figure 1

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科目：工程數學

3.

(a) Find the general solution of the following equation (10%)

$$y'' + 2y' + y = -3e^{-x} + 8xe^{-x} + 1$$

(b) Solve the initial valve problem (15%)

$$ty'' + (4t - 2)y' - 4y = 0 \qquad y(0) = 1$$

4. For the initial valve problem

$$x_1' = 3x_1 - x_2 - x_3 \qquad x_1(0) = 1$$
$$x_2' = x_1 + x_2 - x_3 + t \qquad x_2(0) = 2$$
$$x_3' = x_1 - x_2 + x_3 + 2e^t \qquad x_3(0) = -2$$

(a) First, write this system as $\mathbf{X'=AX+G}$; Find the coefficient matrix **A** and matrix **G**. (2%)

(b) Find the eigenvalues of matrix **A**. (5%)

(c) Find the corresponding eigenvectors for each eigenvalues of matrix **A**. (6%)

(d) Transform this system into an uncoupled system, then solve this initial valve problem. (12%)

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1. 請回答下列問題（共32%，每小題各8%）

① 一部 100 HP 的馬達，其軸的直徑大小是 2000 rpm 的粗，還是 4000 rpm 的較粗。請扼要說明其原因。

② 一部低轉速的馬達，在無量測儀器設備下，有何方法可大略估算出其轉速；請扼要說明其方法。

③ 汽車前視窗內面凝有霧滴妨礙視線，這時是要選擇開冷氣還是開暖氣才有效果，請說明選與不選的理由。

④ 在軸件與孔件的配合制度中，有基孔制與基軸制兩種，其中一般較常使用的為那一種，請扼要說明其理由。

2. 從事新產品或新技術的開發是件非常挑戰性的工作，請以實務經驗舉一實際例子，並詳細說明其開發過程與步驟。（18%）

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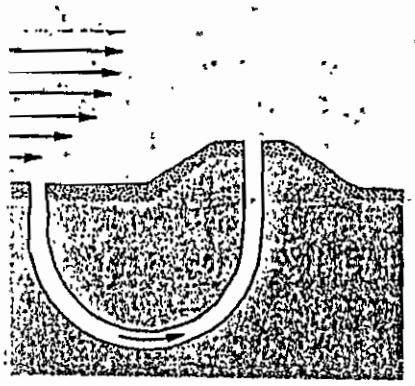
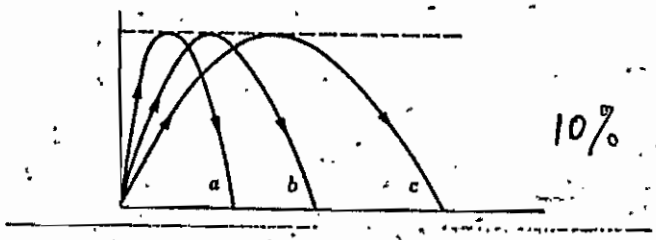
科目：專業實務

3. 

土撥鼠利用流体力學之原理，建築通風性良好的巢穴，試說明其造成通風性良好之原因。 10%

4. Trajectories are shown in Fig. for three kicked footballs. Pick the trajectory for which (*a*) the time of flight is least; (*b*) the vertical velocity component at launch is greatest; (*c*) the horizontal velocity component at launch is greatest; (*d*) the launch speed is least. Ignore air resistance.



10%

5. Air bags greatly reduce the chance of injury in a car accident. Explain how they do so, in terms of energy transfers. 10%

6. 照相机之闪光器，係先以電池充電一電容器後，再接至闪光燈闪光；試說明為何不將電池直接接到闪光燈處進行闪光。 10%

7. 中空之球形導体帶有电荷，試說明球体之内部是否存在有電場？理由？ 10%

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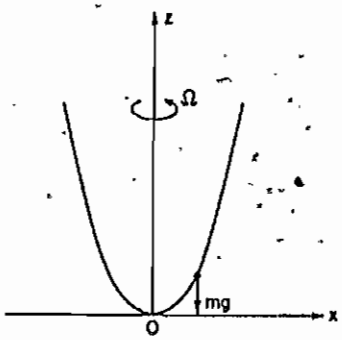
所別：機械工程技術研究所
科目：動力學

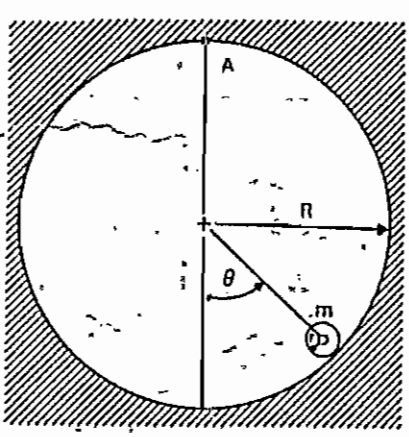
1. Consider the motion of a ring of mass m sliding freely on the wire described by the parabola $z = px^2$ which rotates with a constant angular velocity Ω about the z-axis. Assume that the wire is weightless and there is no outside influence acting on the wire. Find the equation for x describing the motion of the ring.

(25%)



2. A small cylinder of radius r rolls without slip on the circular surface with radius R as shown in the Figure. (a) Find the equation of motion for Θ, and (b) what is the minimum value of $\dot{\Theta}$ at $\Theta = 0$ for which the cylinder will make a complete revolution?

(25%)



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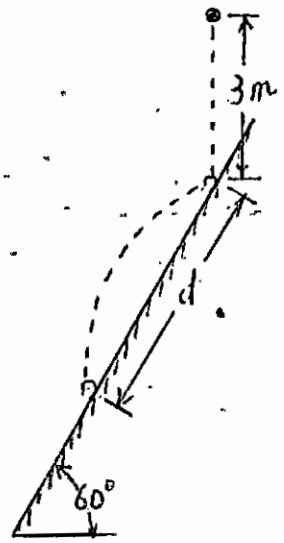
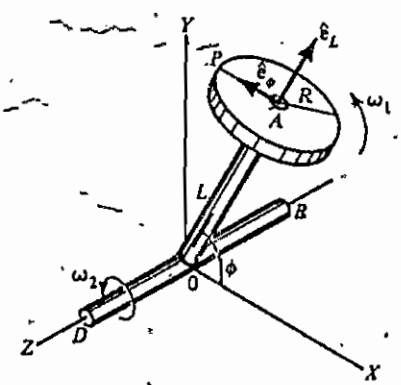
3. The 2-kg ball falls from rest at a height of 3 m above the inclined plane. If the coefficient of restitution is e=0.8, determine the distance d to where it strikes the plane again. Neglect the size of the ball. [25%]



4. The circular disk of radius R shown is rotating about axis OA at angular speed ω_1, increasing at rate $\dot{\omega}_1$. Shaft OA, of length L, is rigidly attached at right angles to a shaft BD that is supported in bearings (not shown) and rotates about the Z-axis at angular speed $\omega_2 = \dot{\phi}$, increasing at rate $\dot{\omega}_2$. Determine

(a) the total angular velocity ω and acceleration α of the disk in terms of the unit base vectors $\bar{I}$, $\bar{J}$, $\bar{K}$ of the fixed axes and the given ω_1, $\dot{\omega}_1$, ω_2, $\dot{\omega}_2$, and ϕ. [10%]

(b) the velocity and acceleration of point P, when it is in the position shown in the XY-plane, in terms of $\bar{e}_L$, $\bar{e}_\phi$, and $\bar{K}$. [15%]



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所別：機械工程技術研究所
科目：電子電路

1. For the circuit in Figure 1, A is an ideal voltage amplifier of gain 100, find the transfer function $\frac{V_o(s)}{V_i(s)}$ and sketch a Bode plot for its magnitude. (25%)

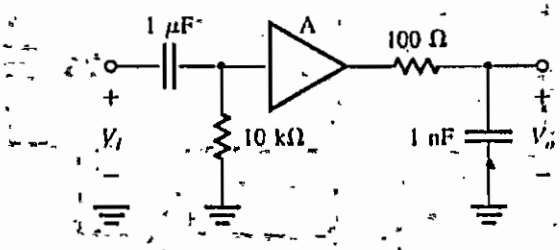

Figure 1

2. Use an inductor, a resistor, and a capacitor to design: (a) a second-order low-pass filter; (b) a second-order high-pass filter; and (c) a second-order band-pass filter. (25%)

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3. 根據圖 3 所示的電路圖回答下列問題(假設二極体在順向偏壓時有 0.7V 的電壓降)：

(A)若 $R_1 = 1k\Omega$ ， $R_2 = 50\Omega$ ，且開關(sw1)爲開(open)的狀態(如圖所示)，則 I_2=？ (8%)

(B)若 $R_1 = 50\Omega$ ， $R_2 = 1k\Omega$ ，且開關爲開(open)的狀態，則 I_2=？ (8%)

(C)若 $R_1 = 1k\Omega$ ， $R_2 = 50\Omega$ ，且開關爲關(close)的狀態，則 I_1=？ I_2=？ (9%)

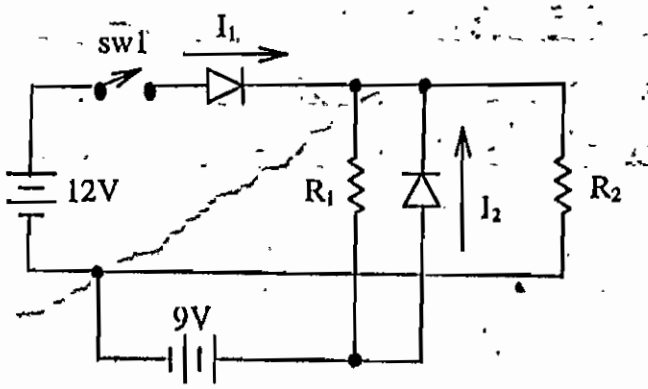

圖 3

4. 根據圖 4 所示電路回答下列問題：

(A) 圖 4a 中，開關(sw1)原本爲開(open)的狀態(如圖所示)，在時間 t = 0 的瞬間將 sw1 關上(close)，而在 t = 1 秒時又將 sw1 打開，畫出流過電感的電流與時間的關係曲線(參照圖 4b)。 (9%)

(B)在測試圖 4a 的電路時，發現 sw1 打開(open)後，電晶体突然燒掉，原因爲何？ (6%)

(C)爲避免電晶体燒掉，可將電路修改如圖 4c 所示。若 sw1 依照(A)所述方式關與開，畫出電感電流與時間的關係曲線(參照圖 4b)。 (10%)

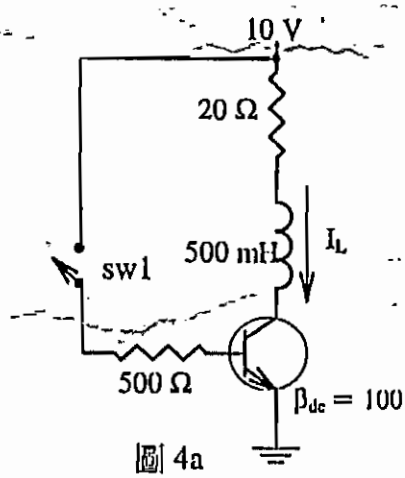

圖 4a

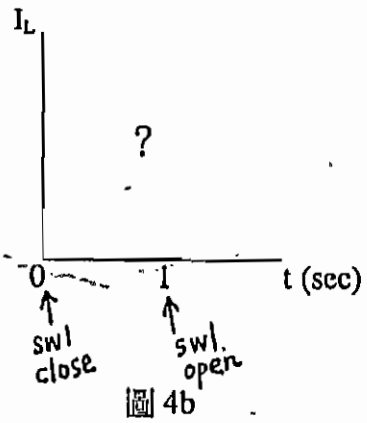

圖 4b

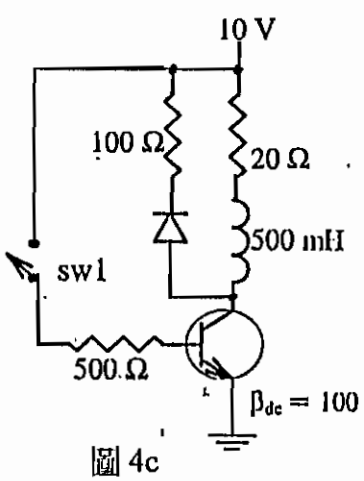

圖 4c

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所別：機械工程技術研究所
科目：機械製造

1. (a) 市面上所謂無縫鋼管如何製作, 有何技術難度上的限制? (6%)

(b) 市售可口可樂鋁罐製作時有哪幾道製造程序, 如何防漏? (9%)

(c) Indicate at least three methods in manufacturing spur gears. What are the advantages and disadvantages of the three methods? (10%)

2. (a) Write down the general procedures needed to manufacture molds for either plastic injection molding or metal-forming. (15%)

(b) What is so-called "process-induced material anisotropies" in plastic or metal forming processes? (10%)

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科目：機械製造

3. (1) Explain what "numerical control" is. Explain why "numerical control" is now more and more important in the manufacturing world . [5 %]

(2) 欲提高金屬切削工具機之精度，必須從它的哪些組成結構來著手改進？說明你的理由。 [7 %]

(3) Describe the following welding processes: [9 %]

(i) soldering

(ii) seam welding

(iii) inert-gas-shield arc welding

(4) 說明鑄造模砂必須具備的特性。 [4 %]

4. (1) 繪圖說明曲柄式牛頭刨床之急回機構，並於圖上詳細標明各元件之名稱。 [5 %]

(2) 如果該刨床在切削衝程中，曲柄之轉動量爲220度，試証明每分鐘的衝程數(N)、衝程長度(L)、和切削速度(CS)三者之關係約爲：

$N = CS\ (7) / L$ (此時 L 之單位爲"英吋")

$N = CS\ (0.6) / L$ (此時 L 之單位爲"米") [6 %]

(3) 說明以下幾種硬度試驗法如何進行: [9 %]

(i) Brinell hardness

(ii) Rockwell hardness

(iii) Vickers hardness

(4) 說明鋼的退火(annealing)如何進行。 [5 %]

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1. a) Describe the difference between closed and open systems. (5%)

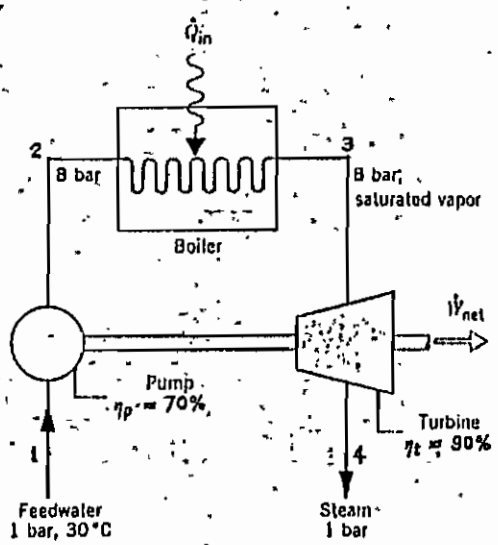
   b) What is the difference between extensive and intensive properties? (5%)

   c) What is the difference between (i) saturated vapor and superheated vapor, (ii) saturated liquid and compressed liquid? (iii) indicate the region corresponding to those status on a constant pressure line in the T-s diagram for water. (10%)

   d) Is it possible to compress an ideal gas isothermally in an adiabatic piston-cylinder device? Why? (5%)

2. As shown in the figure, three devices operate at a steady state: a pump, a boiler, and a turbine. The turbine provides the power required to drive the pump and also supplies power to other devices. For adiabatic operation of the pump and turbine, and ignoring kinetic and potential energy effects, determine, in kJ per kg of steam flowing
   (h_1 = 125.79 kJ/kg, $v_1 = 1.0043 \times 10^{-3}$ m³/kg,
   h_{3g} = 2769.1 kJ/kg, s_{3g} = 6.6628 kJ/kg • K
   s_{4g} = 7.3594 kJ/kg • K, s_{4f} = 1.3026 kJ/kg • K
   h_{4fg} = 2258 kJ/kg, h_{4f} = 417.46 kJ/kg)

   a) the work required by the pump (8%)
   b) the net work developed by the turbine (8%)
   c) the heat transfer to the boiler (9%)



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3. The Berthelet equation of state is given below.

$$P = \frac{RT}{(v - b)} - \frac{a}{Tv^2}$$

where a and b are positive constants. **20%**

(a) Draw a p-v diagram and clearly show the critical isotherm and the saturation dome. (10%)

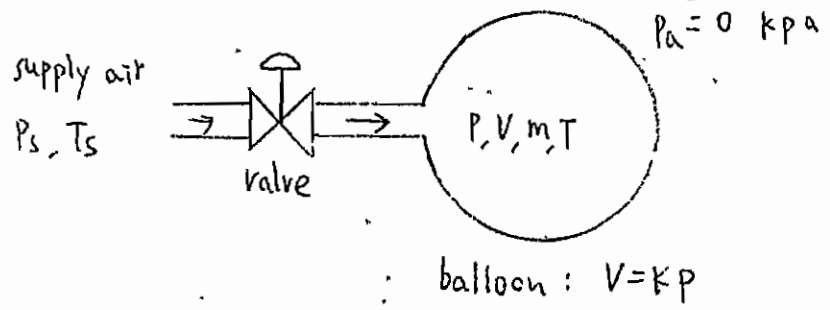
(b) Determine the critical volume in terms of the given constants, a and b. (10%)

4. A supply of compressed air is used to inflate a balloon as shown below. The entire apparatus is contained in a vacuum (P_a = 0 kPa) and the balloon is well insulated. The balloon, assumed massless, is elastic such that its volume is proportional to its pressure according to the relation, V = kP, where k = 0.002 m^3/kPa. The air can be assumed an ideal gas with constant specific heats (c_p=1.0035 kJ/kg-K, c_v=0.7165 kJ/kg-K, R=0.2870 kJ/kg-K). The supply air temperature (T_s) and pressure (P_s) are 10 MPa and 500 K, respectively, **30%**

(a) If the initial pressure (P_i) and the temperature (T_i) of the air in the balloon are 100 kPa and 300 K, respectively, what is the initial mass (m_i) and volume (V_i)? (10%)

(b) Write an energy and mass balance for the balloon in terms of differential quantities if a small amount of supply air (dm_s) is allowed to enter the balloon. Describe what type of energy is represented by each term in this equation. (10%)

(c) Solve the equation derived in (b) for the temperature of the air in the balloon (T) as a function of the mass of air in the balloon (m) as the air is slowly supplied to the balloon. Use the initial conditions from (a) and calculate the temperature of the air in the balloon when its mass is doubled. (10%)



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八十五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：自動控制

1. Consider the system $\dot{x}(t)=Ax(t)+f(t)$. ----------(1)

The system described by the above equation (1) is called bounded-input bounded-output (BIBO) stability if any bounded forcing function f(t), called the input, produces a bounded response x(t), i.e., a bounded output, regardless of the bounded initial condition x(0).

Now, consider the following system:

$$\dot{x}(t)=\begin{bmatrix} 0 & 1 \\ -w^2 & 0 \end{bmatrix} x(t)+f(t) \quad \text{----------(2)}$$

Please discuss the BIBO stability of the above equation (2) using any method.

(25%)

2. Consider the transfer function T(s)=X(s)/F(s) for the second-order mechanical system shown in Figure (1). Assuming the mass M and the stiffness K are fixed, find the locus traced out by the poles of T(s) as the friction coefficient B is incresed from zero toward infinity.

(25%)

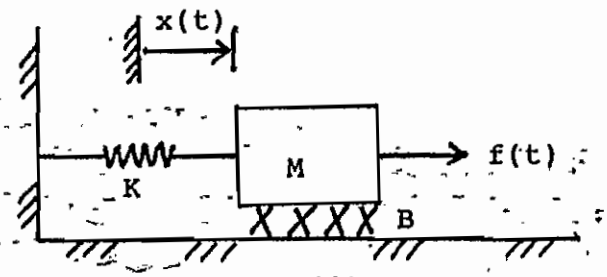

Figure (1).

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3.

Given a linear time invariant system described by transfer function G(s).

Please find the steady state solution y(t) when the system excited by an periodic input as figure2. (25%)

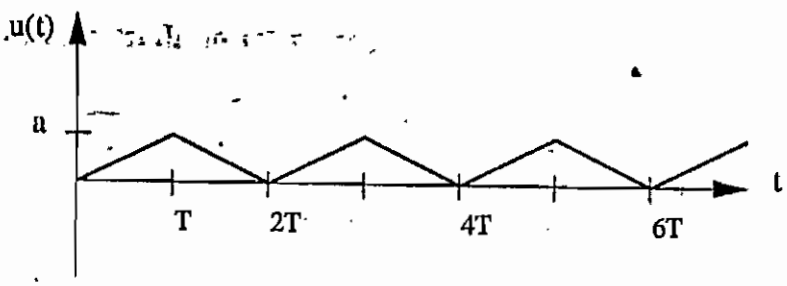

Figure2

4.

對一多迴路(Multi-loop)控制系統，

(1)為何內迴路之頻寬，必須高於外迴路之頻寬？(10%)

(2)若內迴路發生飽和現象(saturation)，為何容易造成系統不穩定？應如何解決？(10%)

(3)積分器常用來消除低頻之干擾(disturbance)，請問應加在干擾之前或之後，並說明為什麼？(5%)

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八十五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

A simple beam with an overhang is loaded as shown in Fig.1 Find the deflection δ_C at the end of the overhang. (25%)

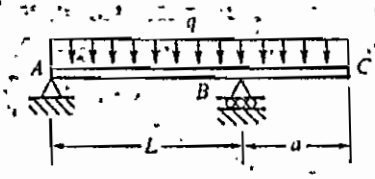

Fig.1 Simple beam with an overhang.

A beam ABC (Fig.2) is simply supported at A and B and is hung from a cable CD at point C. Prior to the application of the uniform load q, there is no force in the cable nor is there any slack in the cable. When the load q is applied, the beam deflects downward at C and a tensile force T develops in the cable. Find the magnitude of this force. (25%)

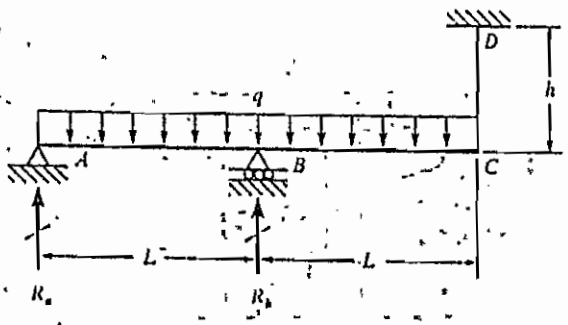

Fig.2 Beam ABC supported by a cable.

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科目：材料力學

3. A cylindrical pressure vessel is constructed with a helical weld that makes an angle of 55° with the longitudinal axis (Fig. 3). The tank has inside radius $r = 1.8$ m and wall thickness $t = 8$ mm. The maximum internal pressure is 600 kPa. Calculate the following quantities for the cylindrical part of the tank: (a) the circumferential and longitudinal stresses; (b) the absolute maximum shear stress; and (c) the normal and shear stresses acting perpendicular and parallel to the weld, respectively. (25%)

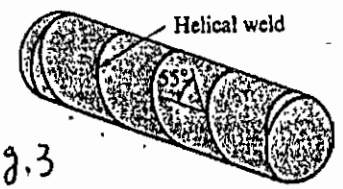

Fig. 3

4. A circular steel cylinder S and a hollow copper circular tube C having the same length L are compressed between the rigid plates of a testing machine by forces P (Fig. 4). Determine the following quantities: (a) the compressive forces P_s and P_c in the steel cylinder and copper tube, respectively; (b) the corresponding compressive stresses σ_s and σ_c in the materials; and (c) the shortening δ of the assembly. (25%)

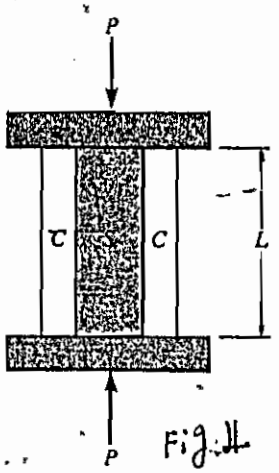

Fig. 4

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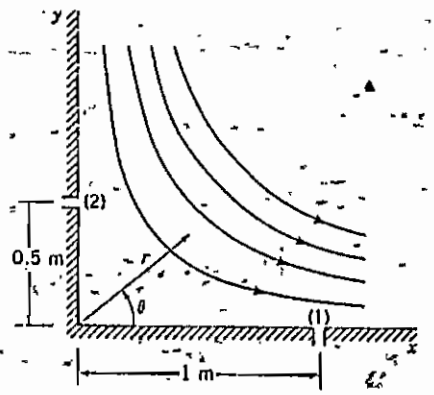
25% [1] The two-dimensional flow of a nonviscous, incompressible fluid in the vicinity of the 90° corner as shown in the Figure is described by the stream function

$$\Psi = 2\,r^2 \sin 2\theta$$

where Ψ has units of m^2/s when r is in meters. (a)Determine, if possible; the corresponding velocity potential, (5%) (b) If the pressure at point (1) on the wall is 30 kPa, what is the pressure at point (2)? Assume the fluid density is 10 kg/m^3 and the x-y plane is horizontal.(5%) (c)Determine the generalized cylindrical polar form to describe flow in the vicinity of a corner of angle α. (15%)



25% [2] A nozzle is attached to an 80 mm inside diameter flexible hose. The nozzle area is 500 mm^2. If the delivery pressure of water at the nozzle inlet is 700 kPa, how much the horizontal force is needed to hold the hose and nozzle stationary ?

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3. In steady state laminar flow condition, a Newtonian fluid flows through a rectangular duct as shown in the attached Fig.2. The cross section is assumed to be very wide compared to its height ($W \gg h$). Flow is in the z-direction and the control volume for the force balance doesn't extend to the wall surface. Determine (a) the fully developed velocity profile, $V_z(y)$ (10%), (b) the volume flow rate Q (8%) (c) the Darcy friction coefficient, f, for the laminar flow through a rectangular duct, where $f \equiv \frac{4\tau}{(\rho V^2/2)}$, τ is the shear stress for a newtonian fluid, and V is the average velocity, $V = Q/A$, $A = W \cdot h$. (7%)
ρ: fluid density.

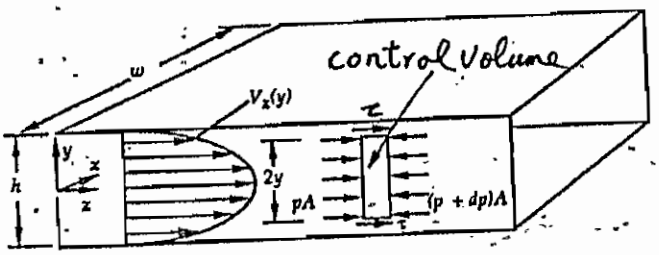

Fig. 2 Laminar flow through a rectangular duct.

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4. Water entering at 10°C is to be heated to 40°C in a tube of 0.02m ID at a mass flow rate of 0.01 kg/s. The outside of the tube is wrapped with an insulated electric heating element that produces a uniform flux of 15000 W/m² over the surface. Neglecting any entrance effects. Determine (a) the length of pipe needed for the (8%) water to be heated to 40°C.

(b) the inner tube surface temperature (8%) at the outlet where $T_{water} = 40°C$.

(c) the pressure gradient in the pipe. (5%)

(d) the pumping power required if the (4%) pump efficiency is 50%.

Properties of water at 25°C can be used for the calculation.

$\rho = 997\ kg/m^3$, $C_p = 4180\ J/kg\,K$

$K = 0.608\ W/m\cdot K$, $\mu = 910 \times 10^{-6}\ N\,s/m^2$

For laminar flow: friction coefficient, $f = \frac{64}{Re_D}$

$(Re_D = \frac{\rho V D}{\mu})$ heat transfer coef. $h = 4.36\,K/D$

For turbulent flow: friction coefficient, $f = \frac{0.316}{Re_D^{0.25}}$

$(Pr = \frac{\mu C_p}{K})$ heat transfer coef. $h = 0.023\,Re^{0.8} \cdot Pr^{0.4}$