國立中山大學９６學年度碩士班招生考試試題

科目：工程數學【機電系碩士班】

I. 選擇題部分 (單選題) (每題 4 分，共計 24 分)

1. Which is a linear differential equation? (1) $y'' = xyy'$, (2) $y' = r(x)y + p(x)$, (3) $y' = r(x,y)y$, or (4) $y' = y^2$, where prime denotes differentiation with respect to x.
2. Laplace transform of t is (1) s^2, (2) $1/s^2$, (3) s, or (4) s^3.
3. Which is wrong for Laplace transform? It is (1) a linear transformation, (2) a transformation between polar and Cartesian coordinates, (3) a method to solve ordinary differential equations, or (4) a method to solve integral equations.
4. An integrating factor of the differential equation ydx-xdy =0 is (1) x^2, (2) $1/x^2$, (3) x, or (4) x^3.
5. Which is wrong for Sturm-Liouville problems? They are (1) eigenvalue problems, (2) governed by ordinary equations having singular points, (3) problems used to find properties of eigenfunctions, or (4) governed by homogeneous linear ordinary differential equations.
6. Which is the criterion to examine the exactness of an ordinary differential equation Mdx+Ndy=0, (1) $\partial M/\partial x = \partial N/\partial y$, (2) $\partial M/\partial y = \partial N/\partial x$, (3) $dM/dx = dN/dy$, or (4) $dM/dy = dN/dx$.

II. 計算題部分 (四題共計 51 分)

1. (15%) Find a basis of eigenvectors and diagonalize the following matrix.

$$\begin{bmatrix} 5 & 10 & -10 \\ 10 & 5 & -20 \\ 5 & -5 & -10 \end{bmatrix}$$

2. (10%) Evaluate the following integral. (Hint: the form under integral sign is exact)

$$\int_{(-1,5)}^{(4,3)} 3y^2 dx + 6xy dy$$

3. Let vector $\mathbf{R} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$ and let $r = \sqrt{x^2 + y^2 + z^2}$ with $r \neq 0$

(a) Find $\nabla(r^n)$ for $n = 1,2,\mathrm{K}$. (6%)

(b) For what values of n is $\nabla^2 r^n = 0$ (5%)

(c) Determine n so that $\nabla \cdot (r^n \mathbf{R})$ will vanish identically. (5%)

4. (10%) Let A and B be real numbers with A > B >0. Show that

$$\int_0^{\pi} \frac{1}{A + B\cos(\theta)} d\theta = \frac{\pi}{\sqrt{A^2 - B^2}}$$

III. 簡答題部分 (每題 5 分，共計 25 分)

The following five problems do not require rigorous nor tedious mathematical proof or derivations. However, you need to explain the reason behind your answers clearly.

1. If $\boldsymbol{A}$ and $\boldsymbol{B}$ are both matrices, is the identity $(\boldsymbol{AB})^{-1} = \boldsymbol{B}^{-1}\boldsymbol{A}^{-1}$ always true? Why or why not?

2. Assuming vectors v_1, v_2 and v_3 are three 2 by 1 vectors, then when can you always find a set of coefficients c_1 and c_2 to satisfy to equality $v_3 = c_1 v_1 + c_2 v_2$ for every possible v_3.

3. Assuming that the Laplace transform for $f(t)$ is $F(s)$ and $F(s) = G(s)e^{-as}$. If the inverse Laplace transform for $G(s)$ is a known function $g(t)$, what is $f(t)$?

4. If $f(t)$ is not a periodic function, then can you perform Fourier series expansion for this function. Why or why not?

5. If periodic function $f(t)$ is already a known function of t, then from an engineering point of view, what is the basic purpose for finding the Fourier series representation for $f(t)$. This is a puzzling question considering the fact that a Fourier series representation of $f(t)$ typically consists of infinite number of terms and thus seems to be much more complex to manipulate than the original representation of $f(t)$.

國立中山大學９６學年度碩士班招生考試試題

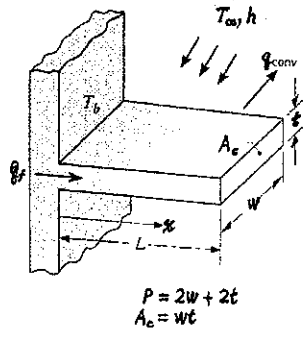
科目：熱力及熱傳導、熱輻射學【機電系碩士班甲組】

Thermodynamics: (65%)

1. (5%) What is the physical significance of the compressibility factor, and what is the principle of the corresponding states?
2. (5%) How do we judge if an isolated chemical reactive system has completely reached its thermodynamic equilibrium state?
3. (5%) If a system is interactive with its surroundings through the three mechanisms mass, heat and work transfers. What are the possible mechanisms, which can cause the energy of a control volume to change, and what are the possible mechanisms, which can cause the entropy of a control volume to change?
4. (5%) A substance whose Joule-Thomson coefficient is negative is throttled to a lower pressure. During this process, (select the correct statement)
   (a) the temperature of the substance will increase.
   (b) the temperature of the substance will decrease.
   (c) the entropy of the substance will remain constant.
   (d) the entropy of the substance will decrease.
   (e) the enthalpy of the substance will decrease.
5. (5%) What is the enthalpy of formation? How does it differ from the enthalpy of combustion?
6. (15%) Please derive the Carnot cycle efficiencies for the heat engines (or power plants), refrigerators, and heat pumps between two thermal reservoirs T and T_o (environmental temperature). In a heat engine or a heat pump, the high temperature thermal reservoir is denoted as T, but in a refrigerator, the low temperature thermal reservoir is denoted as T. The environmental temperature is denoted as T_o in all of the three thermal systems. Use these three derived results to make a plot to denote the Carnot cycle efficiencies of the three types of devices in the same figure. In this figure, the ordinate coordinate could be the thermal efficiency of a heat engine, the coefficient of performance of a refrigerator, or the coefficient of performance of a heat pump, and the abscissa coordinate is dimensionless temperature T/T_o. Please also show the equations of the Carnot cycle efficiencies in terms of T/T_o in this figure.
7. (10%) Derive relations for (a) Δu, (b) Δh, and (c) Δs of a gas that obeys the equation of state $(P+a/v^2)v = RT$ for an isothermal process.
8. (15%, 3% each) For an ideal vapor-compression refrigeration cycle:
   (a) Draw a T-s diagram. Describe each process for the cycle.
   (b) How do you calculate heat and work for each process of the cycle?
   (c) Which process provides refrigeration effect?
   (d) What is the COP for the refrigeration cycle?
   (e) If the cycle is used as a heat pump, what is the COP?

Heat Conduction and Radiation: (35%)

9. (5%) What is the basic law (name and equation) for heat conduction? Why there is a negative sign in the law? Define the thermal conductivity.
10. (5%) What is the Lumped-Capacitance-Method (LCM)? When the LCM is valid?
11. (5%) 冬天清晨發現地上的積水上結了一層薄冰,但氣象報告顯示這幾天氣溫均高於 0 ℃,試解釋該現象之原因。
12. (10%) 試推導出右圖所示之 fin 的一維熱傳方程式。若定義 excess temperature $\theta(x) \equiv T(x) - T_\infty$，將方程式轉變為 θ 的方程式。
    (10%) 假設 fin 的尾端為絕熱，解出 fin 上的一維溫度分布及熱傳率 q_f。



國立中山大學９６學年度碩士班招生考試試題

科目：流體力學及熱對流【機電系碩士班甲組】

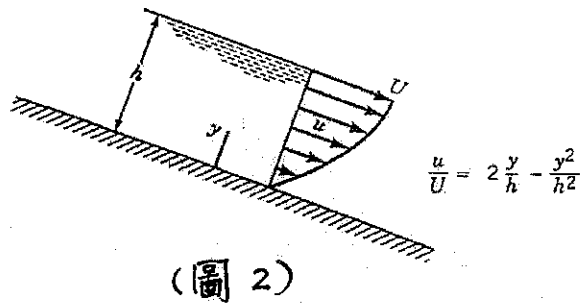
1 (5%)

The viscosity of blood is to be determined from measurements of shear stress, τ, and rate of shearing strain, du/dy, obtained from a small blood sample tested in a suitable viscometer. Based on the data given below determine if the blood is a Newtonian or a non-Newtonian fluid. Explain how you arrived at your answer.

τ (N/m^2)	0.04	0.06	0.12	0.18	0.30	0.52	1.12	2.10
du/dy(s^{-1})	2.25	4.50	11.25	22.5	45.0	90.0	225	450

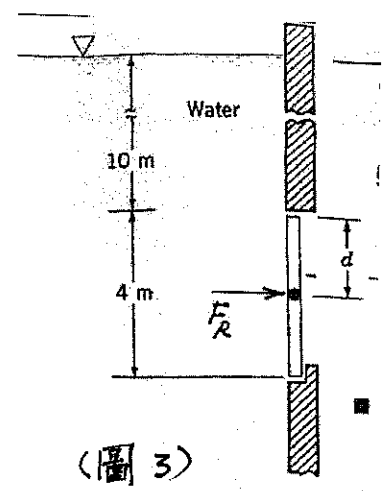
2. (5%)

A layer of water flows down in an inclined fixed surface with the velocity profile shown in the figure. Determine the magnitude and direction of the shearing stress that the water exerts on the fixed surface for U= 3m/s and h=0.1m.
(viscosity of the water $\mu=1.12 \times 10^{-3}$ Ns/m^2)



$$\frac{u}{U} = 2\frac{y}{h} - \frac{y^2}{h^2}$$

(圖 2)



(圖 3)

3. (10%)

A rectangular gate that is 3 m wide is located in the vertical wall of a tank containing water as shown in the figure. It is desired to have the gate open automatically when the depth of water above the top of the gate reaches 10 m.

(a) What is the magnitude of the force on the gate when it opens?

(b) Derive the equation for the y coordinate, y_R, of the resultant force

$$y_R = \frac{I_{xc}}{y_c A} + y_c$$

Where I_{xc} is the second moment of area with respect tp an axis passing through the centroid and parallel to the axis.

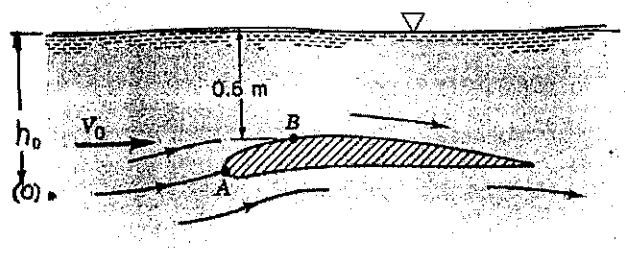
y_c is the y coordinate of the centroid of the area.

(c) At what distance, d, should the frictionless horizontal shaft be located?

Note: For the rectangular area, I_{xc} =(3m)x$(4m)^3/12$. water density=1000kg/m^3, gravitational acceleration=9.8 m/s^2.

4. (5%)

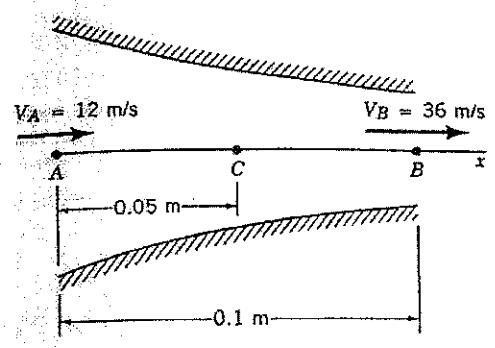
Water flows past the hydrofoil shown in the figure with an upstream velocity of Vo. A more advance analysis indicates that the maximum velocity of the water in the entire flow field occurs at point B and is equal to 1.1 Vo. Calculate the velocity, Vo, at which cavitation will begin if the atmospheric pressure is 101 kPa (abs) and the vapor pressure of the water is 3.2 kPa (abs).



(圖4)

5. (5%)

The fluid velocity along the x-axis shown in the figure changes from 12 m/s at point A to 36 m/s at point B. It is also known that the velocity is a linear function of distance along the streamline. Determine the acceleration at point A, and C. Assume steady flow.



(圖5)

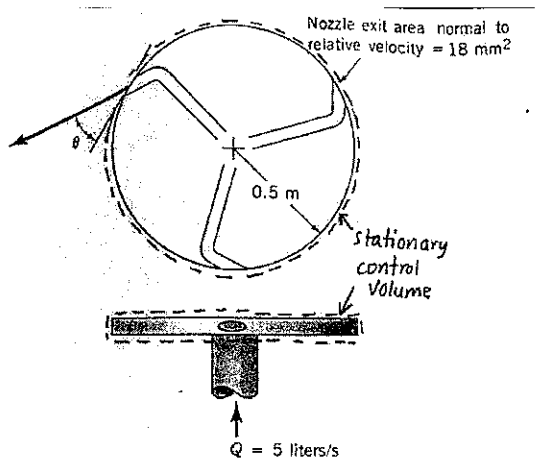
6. (10%)

Five liters/s of water enters the rotor shown in the figure along the axis of rotation. The cross-sectional area of each of the three nozzle exits normal to the relative velocity is 18 mm^2, and θ=30°. The rotor is held stationary.

(a) Calculate the water velocity at the nozzle exit (assume the velocity is uniform at the nozzle exit).

(b) Calculate the torque required to hold the rotor stationary?

(water density=1000kg/m^3, $1m^3$=1000 liter)



(圖6)

7. (10%)

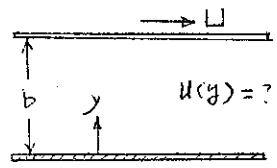
An incompressible viscous fluid is placed between two large parallel plates as shown in the figure. The bottom plate is fixed and the upper plate moves with a constant velocity, U. Assume parallel flow (i.e. u=u(y) only), and zero pressure gradient.

(a) What is the differential equation that u(y) has to satisfy?

(b) What are the boundary conditions to solve for the differential equation in (a)?

(c) Solve for the velocity distribution u(y).(in terms of U, b and y)

(d) Determine the volumetric dilatation rate, and the vorticity of the velocity distribution.



(圖 7)

8. (15%)

Please define and describe the physical significance of the followings

(a) Prandtl number, (b) Peclet number, (c) Grashof number.

9. (20%)

Define : (a) Thermal Boundary Layer, (b) Fully Developed Flow,

(c) Turbulent Boundary Layer Thickness, (d) Prandtl Mixing Length.

10. (15%)

A fluid flows between two large parallel plates. Please develop an expression for the temperature distribution as a function of distance from the centerline between the two plates under developed flow conditions. The temperature(T1) of the plates is lower than the temperature(T2) of the laminar flow.

國立中山大學９６學年度碩士班招生考試試題

科目：應用力學【機電系碩士班乙、丙組】

Please choose the correct answers for problem 1 to problem 3
Please be noted that the correct answers for each problem may be more than one

1. Which statements are correct? **(11%)**
   (A) The displacement of a particle and the distance it travels on its path are not the same thing.
   (B) Consider a planetary motion, as its eccentricity becomes smaller, an elliptical orbit becomes more circular.
   (C) Consider a body attached to a fixed point by a spring. When the spring is away from its undeformed position, the work of the force exerted by the spring is negative.
   (D) In an inelastic collision, kinetic energy is not conserved, but momentum is conserved.
   (E) In a perfectly plastic collision between two bodies, the velocities of the bodies immediately after the collision are equal to the velocity of the center of mass of the system.
   (F) The linear momentum of a particle in a system of particles is affected by internal forces.
   (G) A particle that moves with constant acceleration is not in equilibrium.
   (H) Suppose that two satellites are in the same circular orbit with satellite A leading satellite B by some angle θ. Then satellite B must slow down rather than speedup if it wants to catch satellite A
   (I) When a 4-wheels driving automobile moves to right, the directions of friction forces at the wheels are directed to right also.
   (J) When a disk rolls without sliding on a rough surface, the magnitude of the friction force F may have any value as long as this value does not exceed $\mu_s N$, where μ_s is the coefficient of static friction & N is the magnitude of the normal force.
   (K) Spring force is a conservative force, but friction force is a non-conservative force.
   (L) None of the previous statements is correct.

2. If an automobile's braking distance from 100 km/h is 60 m on level pavement, and it is assumed that the total frictional force, F_{br}, of the pavement on the tires has a constant value after the brakes are applied. Then which statements are correct? **(12%)**
   (A) The magnitude of the deceleration of the automobile is between 6 m/s^2 and 7 m/s^2.
   (B) The value of F_{br}/M is greater than 6 m/s^2 where M is the mass of the automobile.
   (C) The same automobile's braking distance from 100 km/h is less than 25 m when the automobile is going up a 30° incline.
   (D) The magnitude of the deceleration of the automobile in the statement (C) is greater than 13 m/s^2.
   (E) None of the previous statements is correct.

3. A ball is thrown from point A with an initial velocity $\mathbf{v}_A$ of 18 m/s at an angle of 25° with the horizontal. Let point B be the point of the trajectory described by the ball where the radius of curvature is equal to three-quarters of its value at A. The air resistance can be neglected. Which statements are correct? **(12%)**
   (A) The radius of curvature of the trajectory at point A is less than 33 m.
   (B) The horizontal speed of the ball at point A is less than 15 m/s.
   (C) The normal acceleration of the ball at point B is greater than 8 m/s^2.
   (D) The total speed of the ball at point B is greater than 13 m/s.
   (E) None of the previous statements is correct.

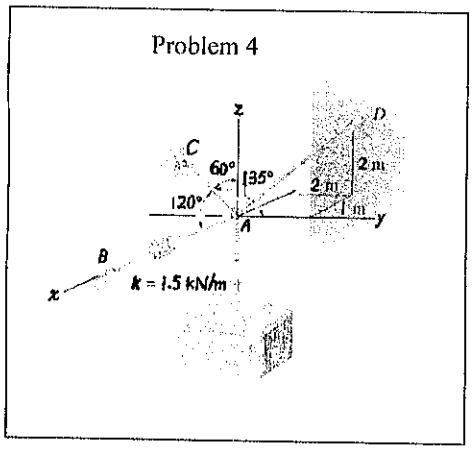
國立中山大學９６學年度碩士班招生考試試題

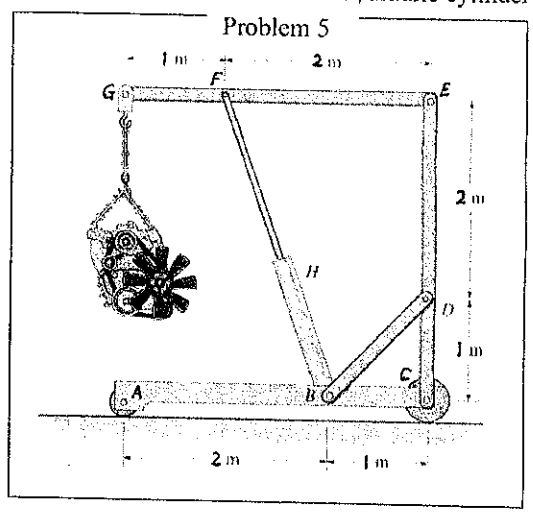
科目：應用力學【機電系碩士班乙、丙組】

Please write details of your answers for problem 4 to problem 7

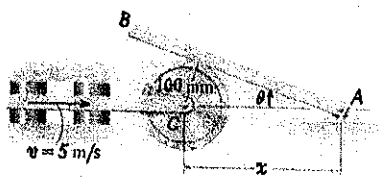
4. The 100-kg crate is supported by three cords, one of which is connected to a spring. (a) Determine the tension in cords *AC* and *AD* and the stretch of the spring. (b) Determine the angle between cords *AC* and *AD*. **(15%)**

5. The hoist supports the 125-kg engine. Determine the force in member *DB* and in the hydraulic cylinder *H* of member *FB*. **(15%)**

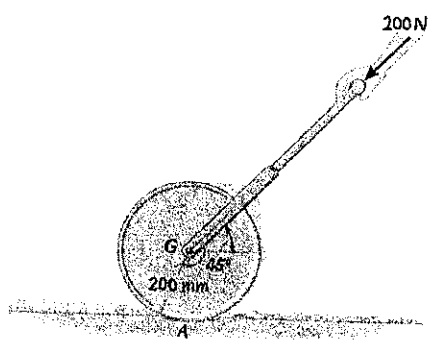




6. Determine the angular velocity of rod *AB* when θ=30°. The shaft and the center of the roller *C* move forward at a constant rate $v = 5$ m/s. **(15%)**



7. The lawn roller has a mass of 80 kg and a radius of gyration $k_G = 0.175$ m. If it is pushed forward with a force of 200 N when the handle is at 45°, determine its angular acceleration. The coefficients of static and kinetic friction between the ground and the roller are $\mu_s = 0.12$ and $\mu_k = 0.1$, respectively. **(20%)**



國立中山大學９６學年度碩士班招生考試試題

科目：材料力學【機電系碩士班乙組】

Part I: **To select the proper answer for following questions (5% for each)**

(1) *Assume the stress tensor at a point is* $[\sigma_{ij}]=\begin{bmatrix} 12 & 4 & 0 \\ 4 & 6 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ (MPa)

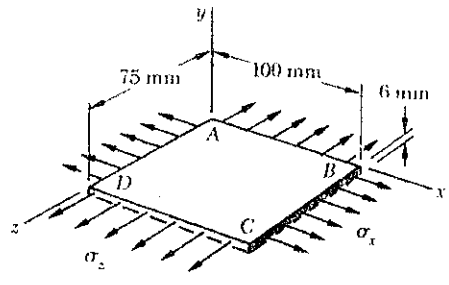
1. ( ) The principal stresses at this point is
   (A) $\sigma_1 = 14;\ \sigma_2 = 4$ *and* $\sigma_3 = 0\ MPa$ (B) $\sigma_1 = 12;\ \sigma_2 = 6$ *and* $\sigma_3 = 0\ MPa$
   (C) $\sigma_1 = 18;\ \sigma_2 = 0$ *and* $\sigma_3 = 0\ MPa$ (D) $\sigma_1 = 0;\ \sigma_2 = -4$ *and* $\sigma_3 = -14\ MPa$
   (E) None

2. ( ) The maximum shear stress at this point is
   (A) $\tau_{max} = 5.0\ MPa$ (B) $\tau_{max} = 7.0\ MPa$ (C) $\tau_{max} = 9.0\ MPa$
   (D) $\tau_{max} = -10\ MPa$ (E) None

3. ( ) The stress state at this point is
   (A) a pure bending stress state (B) a pure torsion stress state
   (C) a pure transverse shear stress state (D) a plane stress state (E) None

4. ( ) The von-Mises stress at this point is
   (A) $\sigma' = 5.75\ MPa$ (B) $\sigma' = 10.22\ MPa$
   (C) $\sigma' = 12.49\ MPa$ (D) $\sigma' = 17.66\ MPa$ (E) None

(2) *A homogeneous plate ABCD is subjected to a biaxial loading which results in the normal stress* $\sigma_x = 150\ MPa$ *and* $\sigma_z = 100\ MPa$. *Knowing that the plate is made of steel which* $E = 200\ GPa$ *and Poison's ratio* $\nu = 0.30$.



5. ( ) The change in length of edge AB is
   (A) $+7.5\mu m$ (B) $+10.8\ \mu m$ (C) $+60.0\mu m$ (D) $+120\mu m$ (E) None

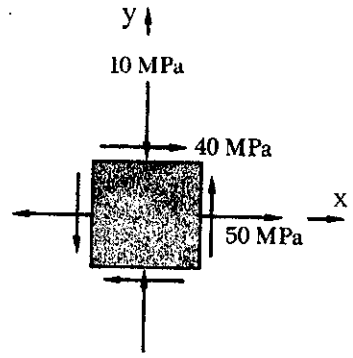
6. ( ) The change in length of edge BC is
   (A) $+7.5\mu m$ (B) $+8.8\ \mu m$ (C) $+10.4\mu m$ (D) $+20.6\mu m$ (E) None

7. ( ) The change in length of diagonal AC is
   (A) $+47.5\mu m$ (B) $+60.4\ \mu m$ (C) $+101.4\mu m$ (D) $+205.6\mu m$ (E) None

國立中山大學９６學年度碩士班招生考試試題

科目：材料力學【機電系碩士班乙組】

(3) *For the state of plane stress shown in following figure* (5% for each)



8. ( ) *The corresponding stress tensor is*

(A) $\begin{bmatrix} 50 & -40 & 0 \\ -40 & 10 & 0 \\ 0 & 0 & 0 \end{bmatrix}(MPa)$ (B) $\begin{bmatrix} 50 & 40 & 0 \\ 40 & -10 & 0 \\ 0 & 0 & 0 \end{bmatrix}(MPa)$

(C) $\begin{bmatrix} 50 & -40 & 0 \\ -40 & -10 & 0 \\ 0 & 0 & 0 \end{bmatrix}(MPa)$ (D) $\begin{bmatrix} -50 & 40 & 0 \\ 40 & -10 & 0 \\ 0 & 0 & 0 \end{bmatrix}(MPa)$ (E) None

9. ( ) The maximum principal stress is

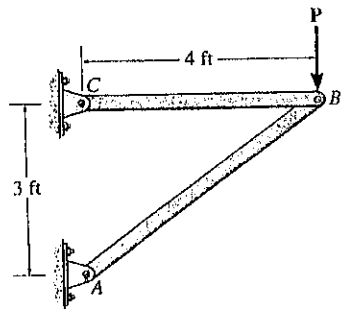
(A) $\sigma_{max} = 70.0\ MPa$ (B) $\sigma_{max} = 50.0\ MPa$ (C) $\sigma_{max} = 40.0\ MPa$
(D) $\sigma_{max} = 30.0\ MPa$ (E) None

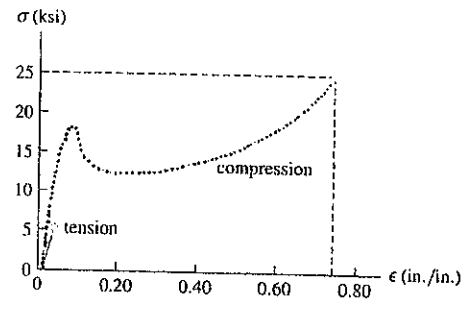
10.( ) The maximum shearing stress is

(A) $\tau_{max} = 70.0\ MPa$ (B) $\tau_{max} = 50.0\ MPa$ (C) $\tau_{max} = 40.0\ MPa$
(D) $\tau_{max} = 30.0\ MPa$ (E) None

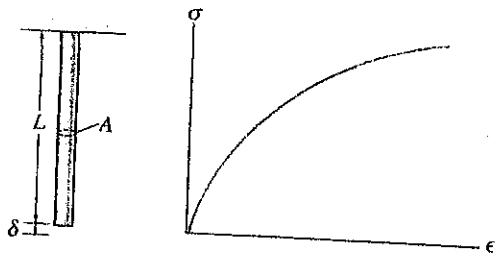
Part II: To answer the following problems:

1. The two bars are made of polystyrene, which has the stress-strain diagram shown. Determine the cross-sectional area of each bar so that the bars rupture simultaneously when the load *P=3 kip*. Assume that buckling does not occur. (20%)

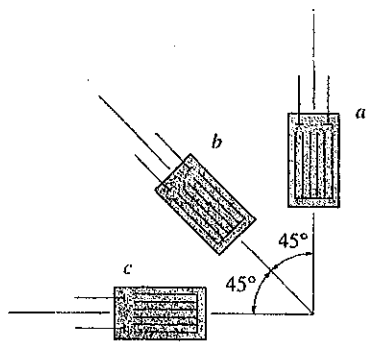




2. A material has a stress-strain diagram that can be described by the curve $\sigma = c\varepsilon^{1/2}$. Determine the deflection δ of the end of a rod made from this material if it has a length L, cross-sectional area A, and a specific weight γ. (15%)



3. The $45°$ strain rosette is mounted on a machine element. Following readings are obtained from each gauge: $\varepsilon_a = 650\left(10^{-6}\right)$, $\varepsilon_b = -300\left(10^{-6}\right)$, $\varepsilon_c = 480\left(10^{-6}\right)$. Determine (a) the in-plane principal strains and (b) the maximum in-plane shear strain and associated normal strain. In each case show the deformed element due to these strains. (15%)



國立中山大學９６學年度碩士班招生考試試題

科目：自動控制【機電系碩士班丙組】

1. Consider a feedback control system. It is acknowledged that an increase of the type number of open-loop system will improve the control accuracy but deteriorate the control stability. Please discuss the reason(s) of above statement. 20%

2. It is known that the effect of hidden poles (of open-loop system) may worsen the stability of a feedback control system when the control gain is improperly large. Please discuss the reason(s) of above statement. 15%

3. Consider a unity-feedback control system whose open-loop transfer function is written as $\frac{K\cdot(s+30)}{s\cdot(s+15)(s^2+20s+400)}$. Please find the range of K that the closed-loop system is stable. 15%

4. It is given a system whose transfer function is written as $\frac{100(s+1)\cdot e^{-0.01s}}{s(s^2+20s+400)}$.

   Please draw the Bode diagram of the system. 20%

5. Consider a unity-feedback control system. It is desired that the bandwidth of the closed-loop control system is larger than 1000 rad/sec. Besides, the damping ratio of the dominate closed-loop pole(s) is better than 0.4. Please draw a possible polar plot of open-loop system that may result in a control performance close to above requirements. 30%

國立中山大學９６學年度碩士班招生考試試題

科目：動力學【機電系碩士班丁組】

一、 填充題 50%

1. For a modeled 1-DOF system, (a) and (b) can be used to determine the equivalent mass (m) and spring constant (k), respectively. The natural frequency of the system can then be writtrn as (c). (12%)

2. The equations of motion of a vibrating system are usually in the form of a set of (a) equations for a lumped system or called a (b) system. And it is (c) equations for a distributed system or called a (d) system. (8%)

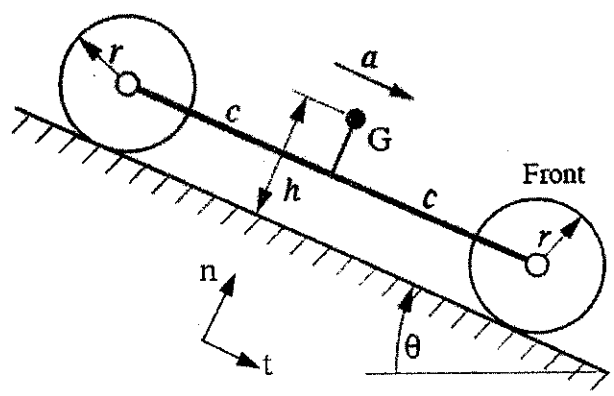
3. List four common approaches, (a), (b), (c), and (d), that can be used to drive the equations of motion of a vibrating system. (8%)

4. In dynamic systems, three common types of damping are (a), (b), and Hysteretic damping. The logarithmic decrement represents the rate at which the (c) of a free-damped vibration decreases. And the addition of such damping will (d) the natural frequency of the system. By measuring two consecutive displacement responses, the (e) can be used to calculate the (f) of a free-damped system. (12%)

5. The natural frequency of a modeled 1-DOF spring-mass system is found to be 2 Hz. When an additional mass of 1 kg is added to the original mass m, the natural frequency is reduced to 1 Hz. The mass m is (a) and the spring constant is (b). (10%)

二、計算與說明題 (50%)

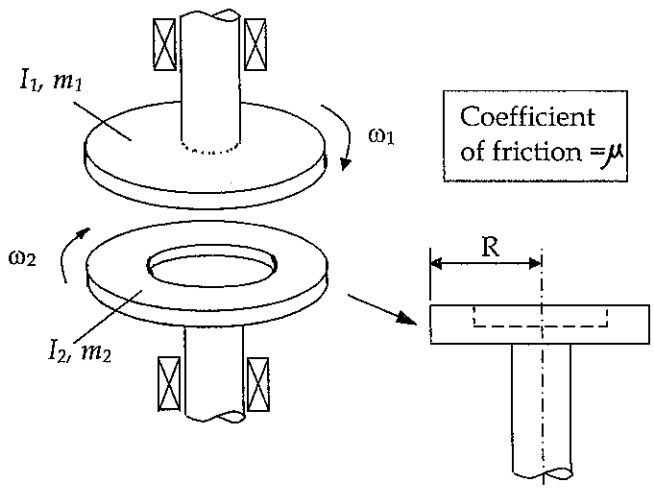
6. The four-wheeled vehicle shown slides down a steep slope with its rear wheels locked (not moving relative to the body) and its front wheels rolling freely. If M is the mass of the vehicle, h the normal distance from its center of mass, G, to the ground, r the wheel radius, and $2c$ the distance between the axles. The angle of the slope is θ and the coefficient of friction between the wheels and the ground is μ. The mass and moment of inertia of each wheel about its axle may be neglected.
(a) Draw the free body diagram for this vehicle. (4%)
(b) List the equations of motion relative to an n-t coordinate system with t parallel to and n normal to the direction of motion as shown in the figure below. (Note: there are three equations of motion in this system.) (6%)
(c) Find the acceleration of the vehicle. (10%)
(d) What is the largest value for the angle θ at which the vehicle will not slide? (10%)



國立中山大學９６學年度碩士班招生考試試題

科目：動力學【機電系碩士班丁組】

7. Two disks are initially spinning freely in the direction shown in the figure. The upper disk is made to descend very slowly until it is a very small distance above the lower disk. It then is released and falls into contact with the rim of the lower disk. (Assume that there is no rebound after the initial contact.)
   (a) Determine the common rotation rate the disks ultimately attain due to sliding friction at the rim. (5%)
   (b) Determine the elapsed time from the instant of release until the disks attain their common rotation speed. (Assume that initially $\omega_1 > \omega_2$.) (5%)
   (c) Derive an expression for the energy loss. (Note: $\Delta E = E_{initial} - E_{final}$) (5%)
   (d) Identify which of the three answers (common angular speed, elapsed time, energy loss) would be the same if the two disks were locked together instantaneously, rather than slipping) (5%)



國立中山大學９６學年度碩士班招生考試試題

科目：靜力學【機電系碩士班丁組】

1. Locate the centroid of the area under the curve $x = ky^3$ from x=0 to x=a. (10%)
2. Calculate and plot the shear and moment diagrams for the beam loaded as shown. (20%)

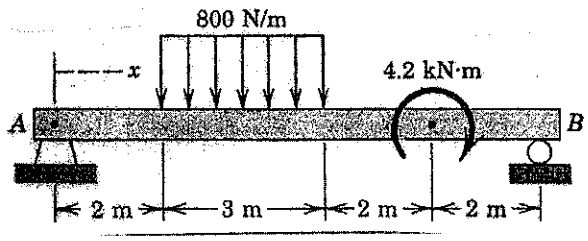


Figure P2

3. For link OA in the horizontal position shown, use principle of virtual work to determine the force P on the sliding collar which will prevent OA from rotating under the action of the couple M. Neglect the mass of the moving parts. (20%)

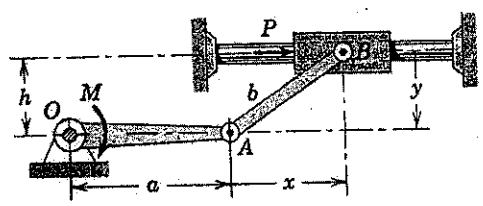


Figure P3

4. Determine the force exerted on the bolt by the bolt cutters and the magnitude of the force the members exert on each other at the pin connection A. (15%)

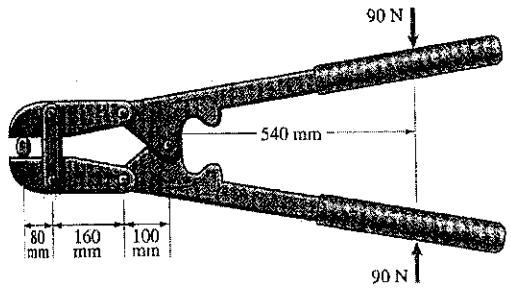


Figure P4

5. As shown in Figure P5, the truss supports loads at ***N***, ***P***, and ***R***. Determine the axial forces in members ***IL*** and ***KM***. (15%)

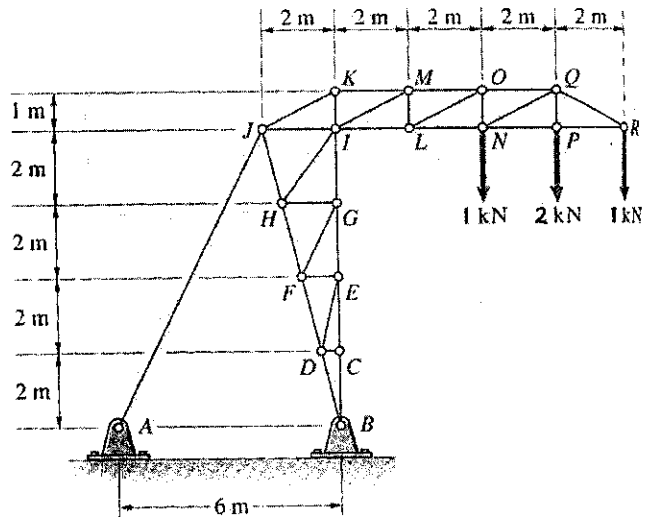


Figure P5

6. As shown in Figure P6, the mass of the 3-m bar is 20 kg, and the coefficient of static friction between the ends of the bar and the circular surface is $\mu_s = 0.3$. What is the largest value of the angle α for which the bar will not slip?(20%)

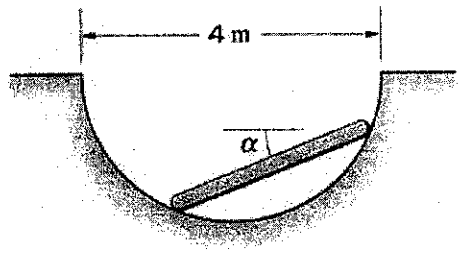


Figure P6

國立中山大學９６學年度碩士班招生考試試題

科目：材料力學【機電系碩士班戊組選考】

1. The steel rod ACB is attached to rigid supports as shown in Fig. 1. It is unstressed at a temperature of 25 °C. The steel is assumed to be elastoplastic with E = 200 GPa and yielding stress σ_{yp} = 250 MPa. The temperature of both portions of the rod is then raised to 150 °C. Knowing that $\alpha = (11.7 \times 10^{-6})$ /°C, determine (a) the stress in both portions of the rod, 20%, (b) the deflection of point C. 10%

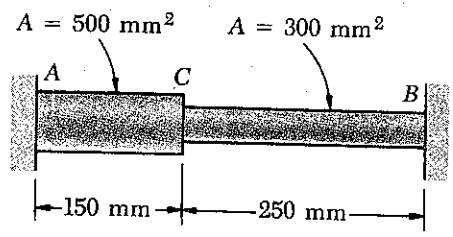


Fig. 1

2. The composite shaft shown consists of a 5-mm-thick brass jacket (brass's G = 39 GPa) bonded to a 40-mm-diameter steel core (steel's G = 77 GPa) as shown in Fig. 2. Knowing that the shaft is subjected to a 600 N-m torque, T. Determine (a) the maximum shearing stress in the brass jacket, 15% (b) the maximum shearing stress in the steel core, 15 %

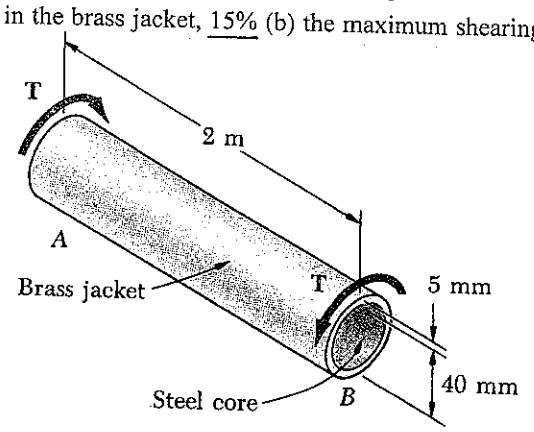


Fig. 2

3. For the beam and loading as shown in Fig.3, determine the reaction at the roller support. 20%

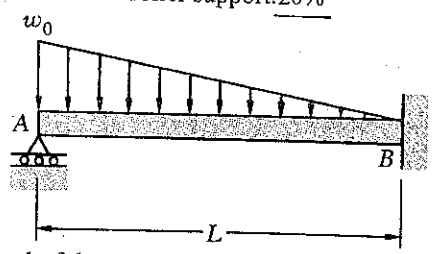


Fig. 3

4. A load P is supported at B by two rods of the same material and of the same cross-sectional area, A, and elastic module, E, as shown in Fig. 4. Determine the horizontal deflection of point B. 20%

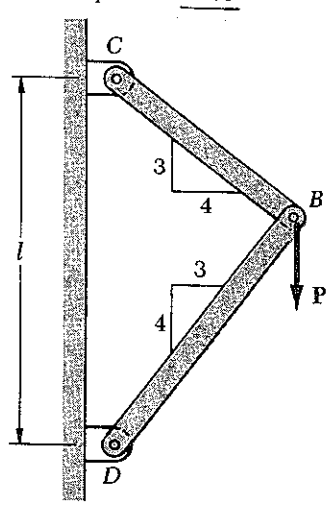


Fig. 4

國立中山大學９６學年度碩士班招生考試試題

科目：材料科學【機電系碩士班戊組選考】

一　(20%)

請說明工程材料有那幾大類？及其各自的特點（例如優缺點）。

二　(20%)

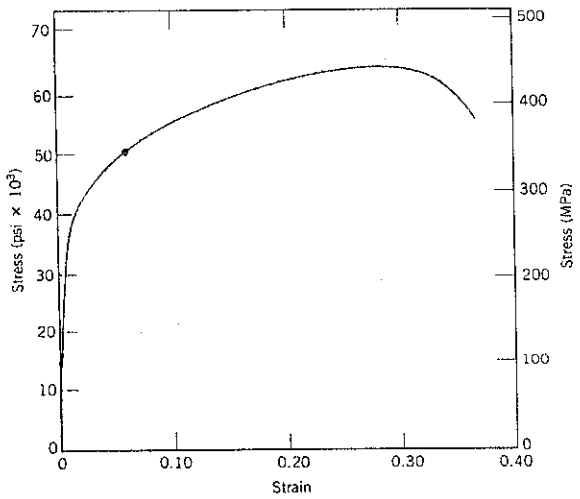
請利用原子結構解釋爲什麼金屬可彎曲，橡膠可拉伸，而玻璃會破碎。

三　(20%)

下圖爲一銅柱之tensile stress - strain之特性圖，請計算：

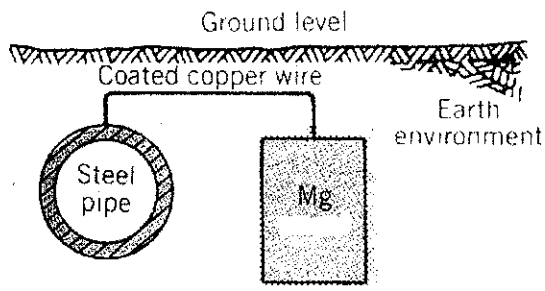
1　modulus of elasticity (Young's modulus).

2　若其直徑爲12.8 m.m.，其所能承受之最大負載爲何？



四　(20%)

防治地下鐵管生鏽，可以如下圖，用導線連接鎂(Mg)或鋅(Zn)，請說明其原理爲何？



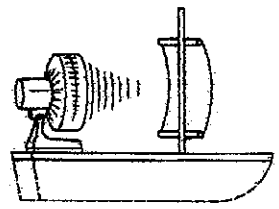
五　(20%)

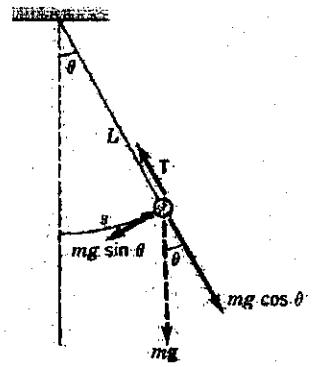
電子封裝的一種flip chip technique，主要由IC晶片，PC板，及兩者之間的膠所構成。你認爲這三個組件的材料選擇，應該考慮哪些？

國立中山大學９６學年度碩士班招生考試試題

科目：普通物理【機電系碩士班戊組選考】

1. 在一風平浪靜的日子，水手決定用一大的電風扇去吹船帆，以使船向前進，如圖所示，請問（a）其效力如何？爲甚麼？（b）又，有另外的方法用電風扇吹，使船動的更有效嗎？原因爲何？（10%）





2. 一簡諧運動的單擺，繩長 L 與其上掛之物質量 m，受力如左圖。假若繩之質量可忽略，擺動之角度 θ 是小角度，請導出（a）物體之受力運動方程式，（b）簡諧運動的角頻率（c）擺動的週期。（10%）

3. 一個均質的棒子有質量 m 及長度 L，懸掛其一端點，令其如單擺自由擺動。求（a）擺動棒子的轉動慣量 I 爲多少？（b）擺動的週期，（c）如此週期的擺動，相當於簡諧運動的單擺繩長爲多少？（10%）

4. 理想氣體一摩爾（mole）在 0℃及 1 大氣壓（1 atm, $P=1.01\times10^5$ N/m^2）下，體積爲 22.4 升（Liter）。請問（a）理想氣體的氣體常數 R＝？（b）若一理想氣體在 20℃，壓力爲 0.8 atm，有體積 0.6 升，問其有多少摩爾氣體？（c）氣體分子數目爲多少？（10%）

5. 三摩爾的氦氣初始溫度在 20℃，壓力爲 1 atm，（a）求其體積爲多少？若其體積膨漲爲 2 倍時，求其在（b）等溫時，（c）等壓力時，作功各爲多少？（d）又在（c）等壓力時最後的溫度爲多少？（15%）

6. 一個非導電的球體，半徑爲 Ro，總電荷爲 Q。電荷均勻分佈於全體積。求其（a）在球體內，距中心 r 處（b）在球體表面處，（c）在球體外 R 處之電場。（15%）

7. 一個平行板電容器，平行板面積 A，距離 d，上有電荷 +Q 及 －Q。（a）求其中心處之電場 E，（b）平行板電容器之電容 C，（c）若一個平行板電容器距離 d= 1 mm，並有 1F 電容時，求其面積 A 爲多大？（$\varepsilon o = 8.85\times10^{-12}$ F/m）（15%）

8. 三用電表內有高電阻、低電阻及電池作量電阻之電源。說明（a）外接量測電壓時，內電阻與外電源是如何接的？（b）外接量測一電流時，內電阻與外電流源是如何接的？（c）這些內電阻有何功能？爲何內電阻不會影響外部量測之值？（15%）

國立中山大學９６學年度碩士班招生考試試題

科目：普通化學【機電系碩士班戊組選考】

1. 商業上純化鋁的方式為將鋁土 $Al(OH)_3$ 與苛性鈉 NaOH 及氫氟酸 HF 混合，之後再將產物熔融成 Al_2O_3 後與碳共燒形成鋁，請寫出此三個化學式。（10%）

2. 請說明同為高分子材料 PC，PE，PMMA，PP 這四者中（均為一般之低密度產品），何在常溫常壓下為延性材料，何為脆性材料，並說明原因。（10%）

3. 請寫出乙醇、丙酮、異丙醇、乙二醇、乙醛之英文化學名及化學式，並排列其沸點高低。（10%）

4. 請說明什麼是無電鍍(electroless plating)以及其基本操作原理。（10%）

5. 請分別比較以下三組化學物之酸強度 （A） HSO_4^- 及 H_2SO_4 （B） HIO, HClO 及 HBrO （C） $HClO, HClO_2, HClO_3, HClO_4$。（10%）

6. Calculate the concentrations of hydronoium ion (H_3O^+) and hydroxide ion (OH^-) at 25°C in a. 0.15 M of HNO_3 and b. 0.010 M of $Ca(OH)_2$ (10%)

7. Calculate the standard emf of the following voltaic cell at 25°C using standard electrode potentials. $Zn_{(s)}|Zn^{2+}{}_{(aq)}$ (10^{-5} M)$||Ag^+{}_{(aq)}$ $(10^{-2}\ M)|Ag_{(s)}$, where $E°_{Zn}$ = -0.76 V, $E°_{Ag}$ = -0.81 V at 25°C. Note: $E_{cell} = E_{cell}^{o} - (0.0592/n)* log\ Q$（10%）

8. $6NaN_{3(S)} + Fe_2O_{3\ (S)} \rightarrow 3Na_2O_{(S)} + 2Fe_{(S)} + 9N_{2(g)}$ is the major method used in automobile air-bag system to generate gas. How many grams of sodium azide would be required to provide 75.0 L of nitrogen gas at 25°C and 748 mmHg? (10%)

9. The following process $2CH_3COOH_{(l)} + O_{2(g)} \rightarrow 2HC_2H_3O_{2(l)}$ is reacted under pressure at 60°C. In lab., 20.0 g CH_3COOH and 10.0 g O_2 were put into a reaction vessel.
   a. How many grams of acetic acid can be produced by this reaction from these amounts of reactants? (5%)
   b. How many grams of the excess reactant remain after the reaction is complete? (5%)

10. 請說明介面活性劑(surfactant)之工作原理並畫出典型的介面活性劑之化學式 (10%)

國立中山大學９６學年度碩士班招生考試試題

科目：應用力學【機電系碩士班戊組選考】

1. 如圖 1，質量 m 的小球下繫一條足夠長的柔軟、均勻且不可伸長的繩子。繩子的線密度爲λ。將小球以初速度 v_0 從地面垂直上拋，忽略空氣阻力，試求在上拋的過程中，小球的速率 v 隨高度 x 的變化。即求出 v(x)。(20%)

2. 如圖 2，0.05 磅(lb)的子彈 B 以水平速度 1500ft/s 射入被鉤在 A 點重 20 磅(lb)的矩形版。矩形版原本靜止。試求(a)子彈剛射入後矩形版的角速度(b)子彈射入 0.0006 秒後，A 點所受到的作用力。(20%)

3. 如圖 3，繩子繞在一輪子的內鼓輪並承受 200N 的水平拉力。輪子質量 50Kg，迴旋半徑(radius of gyration)70mm。摩擦係數μ_s=0.2，μ_k=0.15。試求輪子的圓心點 G 的加速度以及輪子的角加速度。(20%)

4. 如圖 4，長度 *l* 的均勻細桿水平置於桌上，質心離桌邊緣的距離爲 b，從靜止往下掉落。桿與桌之摩擦係數爲μ。試求桿開始滑動時之角度θ。(20%)

5. 如圖 5，200 磅(lb)重的方塊由重量可忽略的連桿 KC 和 HB 所支撐。A 點的支撐是球窩關節，E 點的支撐無摩擦。如圖 5 所示，KC 與 HB 與方塊的對角線共平面。求各支撐點的作用力。(20%)

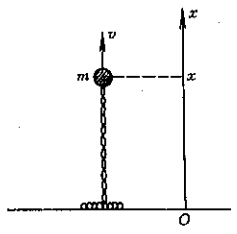


圖 1

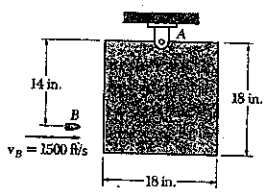


圖 2

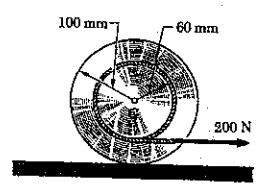


圖 3

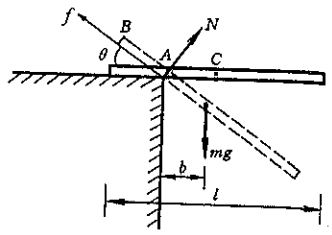


圖 4

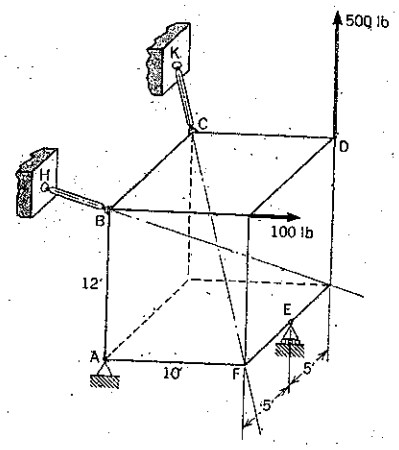


圖 5

國立中山大學９６學年度碩士班招生考試試題

科目：機械製造學【機電系碩士班戊組選考】

1. Describe the operation of the solid laser and state three major industrial laser applications. 20%

2. What are advantages and disadvantages of powder metallurgy? 30%

3. Describe briefly the principle of EDM and explain why graphite is gaining wide acceptance as an electrode material? 20%

4. What is LIGA-like process? 10%

5. Describe briefly the principle of ECM and what are the characteristics of a good electrode tool? 20%