國立中山大學100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. (35%)

1. (25%) Solve the given differential equation by means of a power series about the given point x_0.

   (a) Find the recurrence relation; (5%)

   (b) Find the first four terms in each of two linearly independent solutions (unless the series terminates sooner). (10%)

   (c) Find the general term in each solution. (10%)

$$y'' + y = 0, \quad x_0 = 0$$

2. (10%) $y''' - 3y'' + 2y' = t + e^t, \qquad y(0) = 1,\ y'(0) = -\frac{1}{4},\ y''(0) = -\frac{3}{2}$

   (a) Find the solution of the given initial value problem. (5%)

   (b) Then draw a graph of the solution. (5%)

II. (30%)

1. (10%) In a certain state, 25% of all cars emit excessive amount of pollutants. If the probability is 0.99 that a car emitting excessive amount of pollutants will fail the state's vehicular emission test, and the probability is 0.17 that a car not emitting excessive amount of pollutants will nevertheless fail the test, what is the probability that a car which fails the test actually emits excessive amount of pollutants?

2. (10%) One baseball team won only 41% of their games in the 2010 season. Assuming that this team has a 41% chance of winning each game next season, what is the probability that this team can win exactly 15 games in the first 20 games of the 2011 season?

3. (10%) Please find $(\boldsymbol{AB})^{-1}$ for

$$\boldsymbol{A} = \begin{pmatrix} -1 & 2 \\ 2 & 1 \end{pmatrix} \qquad \boldsymbol{B}^{-1} = \frac{1}{4}\begin{pmatrix} -4 & 0 \\ 4 & 1 \end{pmatrix}$$

III. (35%)

1. (20%) Calculate the line integral $\oint_C \mathbf{F} \bullet \mathbf{r}' ds$ clockwise as seen by a person standing at the origin, where $\mathbf{F} = [-3y, 3x, z]$, $\mathbf{r}'$: the tangent vector, $\bullet$: inner product operation, ds: line increment, C: the circle of $x^2 + y^2 = 4$, $z = 1$.

2. (15%)

   (a) Find the Fourier series of $f(x)$, where $f(x) = -k$ if -1< x <0 and $f(x) = k$ if 0<x <1 with period p=2. (10%)

   (b) Find the sum of $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \ldots$ (5%)

國立中山大學100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】

Part I: Thermodynamics (65%)

1. (5%) Which process requires more energy: completely vaporizing 1 kg of saturated liquid water at 1 atm pressure or completely vaporizing 1 kg of saturated liquid water at 5 atm pressure? Why?

2. (5%) What are the differences among critical pressure, reduced pressure, and relative pressure? What process can we use the relation $P_2/P_1 = P_{r2}/P_{r1}$?

3. (5%) What is the internal energy? List all kinds of the forms of energy that contribute to the internal energy of a system?

4. (10%) An ideal gas with constant specific heat in a closed system expands from the same initial state to the same final volume under adiabatic, isothermal, and isobaric processes, respectively? For which case is the work done greatest and which case is the work done least? If the closed system changes into a control volume, please discuss the work done from the greatest to the least for this similar case.

5. (10%) The air from a glass tube has been completely evacuated before the tip of the tube was fused and seal. You are invited to break the tip of the tube, wait a second or two, and dip the open end of the tube into a beaker containing some water. Do you expect the water to rise into the glass tube, or do you expect air bubbles to come out of the tube into the water? Explain the basis for your expectations.

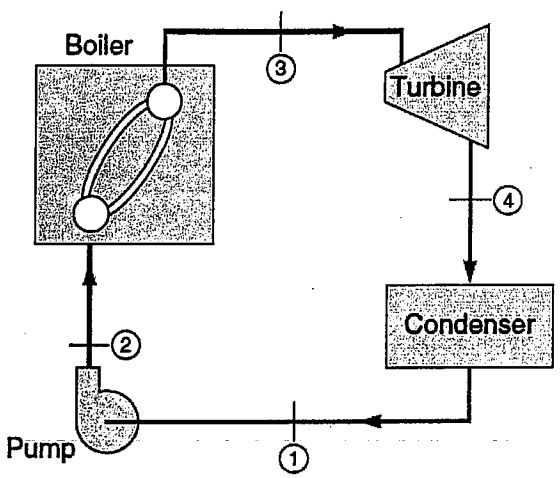
6. (15%) A certain gas obeys the equation of state

$$\mathbf{v} = RT/P - a/T + b$$

where R is a gas constant, and a and b are also constants. Use this equation of state to derive an equation for the Joule-Thomson coefficient inversion line.

7. (5%) An engine delivers 100 hp with a thermal efficiency of 28%. The fuel has a heating value of 38000 kJ/kg. Calculate the rate of fuel consumption.

8. (10%) A Rankine cycle has saturated vapor at 3 MPa entering the turbine. The condenser inlet is 0.01 MPa. Determine the cycle efficiency, and the specific work and heat transfer in each of the ideal components. (properties of the water required are listed in the next page.)



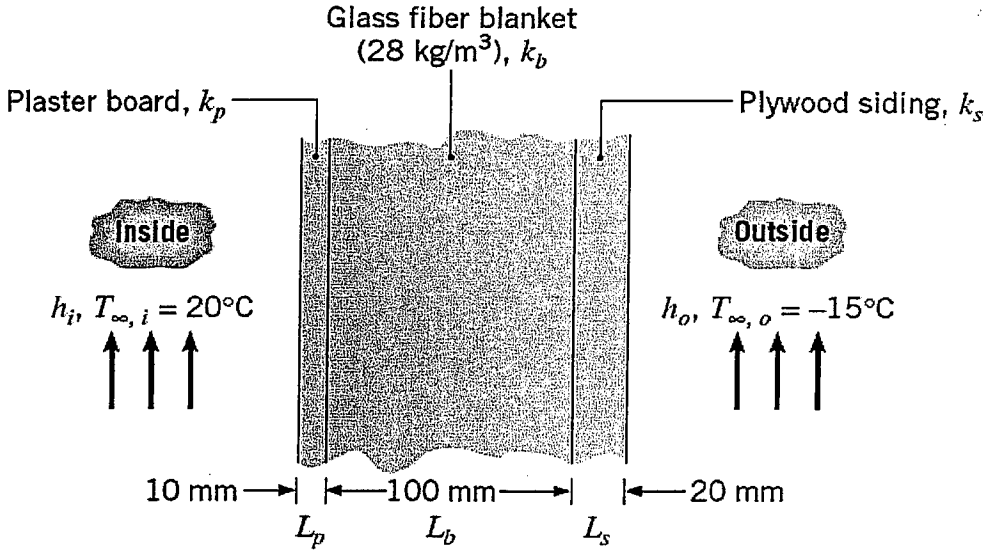
國立中山大學100學年度碩士班招生考試試題

科目：熱力及熱傳導、熱輻射學【機電系碩士班甲組】

Part II: Conduction and Radiation (35%)

9. (5%) What is the green house effect?

10. (15%) As shown in the following figure, a composite wall consists of wood, fiberglass insulation, and plaster board. If the convection heat transfer coefficients are h_o = 60 W/m^2 K and h_i = 30 W/m^2 K. If the total wall surface area is 350 m^2, k_b = 0.038 W/m K, k_s = 0.12 W/m K, k_p = 0.17 W/m K,
    (a) Derive an expression for the total thermal resistance of the wall.
    (b) Calculate the total heat loss through the wall.
    (c) If the h_o is raised to 300 W/m^2 K, calculate the total heat loss through the wall.



11. (5%) (a) Write down the governing equation for a 2-D unsteady conduction problem.
    (5%) (b) What is the lumped-capacitance-method? When is the method valid?
    (5%) (c) Define the Biot number and the Fourier number. What is the physical meaning of the Biot number?

Saturated water—Pressure table

		Specific volume, m³/kg		*Internal energy,* kJ/kg			*Enthalpy,* kJ/kg			*Entropy,* kJ/kg · K		
Press., P kPa	Sat. temp., T_{sat} °C	Sat. liquid, v_f	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Sat. liquid, s_f	Evap., s_{fg}	Sat. vapor, s_g
1.0	6.97	0.001000	129.19	29.302	2355.2	2384.5	29.303	2484.4	2513.7	0.1059	8.8690	8.9749
1.5	13.02	0.001001	87.964	54.686	2338.1	2392.8	54.688	2470.1	2524.7	0.1956	8.6314	8.8270
2.0	17.50	0.001001	66.990	73.431	2325.5	2398.9	73.433	2459.5	2532.9	0.2606	8.4621	8.7227
2.5	21.08	0.001002	54.242	88.422	2315.4	2403.8	88.424	2451.0	2539.4	0.3118	8.3302	8.6421
3.0	24.08	0.001003	45.654	100.98	2306.9	2407.9	100.98	2443.9	2544.8	0.3543	8.2222	8.5765
4.0	28.96	0.001004	34.791	121.39	2293.1	2414.5	121.39	2432.3	2553.7	0.4224	8.0510	8.4734
5.0	32.87	0.001005	28.185	137.75	2282.1	2419.8	137.75	2423.0	2560.7	0.4762	7.9176	8.3938
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	2574.0	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	2583.9	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	2598.3	0.7549	7.2522	8.0071
1750	205.72	0.001166	0.11344	876.12	1720.6	2596.7	878.16	1917.1	2795.2	2.3844	4.0033	6.3877
2000	212.38	0.001177	0.099587	906.12	1693.0	2599.1	908.47	1889.8	2798.3	2.4467	3.8923	6.3390
2250	218.41	0.001187	0.088717	933.54	1667.3	2600.9	936.21	1864.3	2800.5	2.5029	3.7926	6.2954
2500	223.95	0.001197	0.079952	958.87	1643.2	2602.1	961.87	1840.1	2801.9	2.5542	3.7016	6.2558
3000	233.85	0.001217	0.066667	1004.6	1598.5	2603.2	1008.3	1794.9	2803.2	2.6454	3.5402	6.1856

國立中山大學100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】

Part I:Fluid Mechanics (65%)

1. 10%. Water is siphoned from a large tank and discharges into the atmosphere through a 5-cm-diameter tube as shown in Fig. Problem 1. The end of the tube is 1.0 m below the tank bottom, and viscous effects are negligible. (a) Determine the volume flowrate from the tank. (b) Determine the maximum height, H, over which the water can be siphoned without cavitation occurring. Atmospheric pressure is 101.3 kPa (abs), and the water vapor pressure is 1.8 kPa (abs).

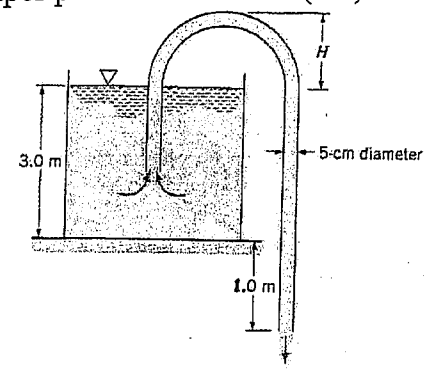


Fig. Problem 1

2. 10%. When a valve is opened, the velocity of water in a certain pipe is given by $u = 10(1 - e^{-t})$, $v = 0$, and $w = 0$, where u is in m/s and t is in seconds. Determine the maximum velocity and maximum acceleration of the water.
3. 15%. A water turbine with radial flow has the dimensions shown in Fig. Problem 3. The absolute entering velocity is 15 m/s, and it makes an angle of 30° with the tangent to the rotor. The absolute exit velocity is directed radially inward. The angular speed of the rotor is 120 rpm. Find the power delivered to the shaft of the turbine.
4. 15%. The velocity potential for a cylinder shown in Fig. Problem 4 rotating in a uniform stream of fluid is

$$\phi = Ur\left(1+\frac{a^2}{r^2}\right)\cos\theta + \frac{\Gamma}{2\pi}\theta$$

where Γ is the circulation. For what value of the circulation will the stagnation point be located at: (a) point A, (b) point B?

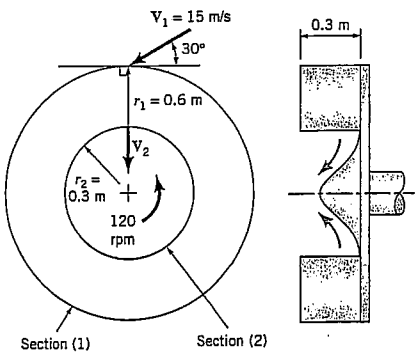


Fig. Problem 3

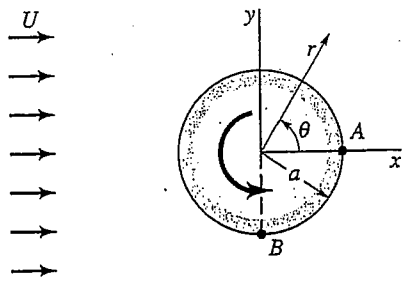


Fig. Problem 4

5. 7%. Air under standard conditions (density = 1.23 kg/m^3, dynamic viscosity = 1.79×10^{-5} N.s/m^2) flows through a 5 mm-diameter commercial steel tubing (roughness = 0.045 mm) with an average velocity of V = 60 m/s. Determine the pressure drop in a 50 cm section of the tube.
6. 8%. Water at 15 °C (kinematic viscosity = 1.15×10^{-6} m^2/s) flows steadily past a flat plate with a velocity of U = 3 m/s. At approximate what location (x_{cr}) will the boundary layer become turbulent? If the plate total length is L = 1 m, what is the drag (per unit width) acting on the plate from x = 0 to x = x_{cr}? What is the drag acting on the plate from x = 0 to x = L?

國立中山大學100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】

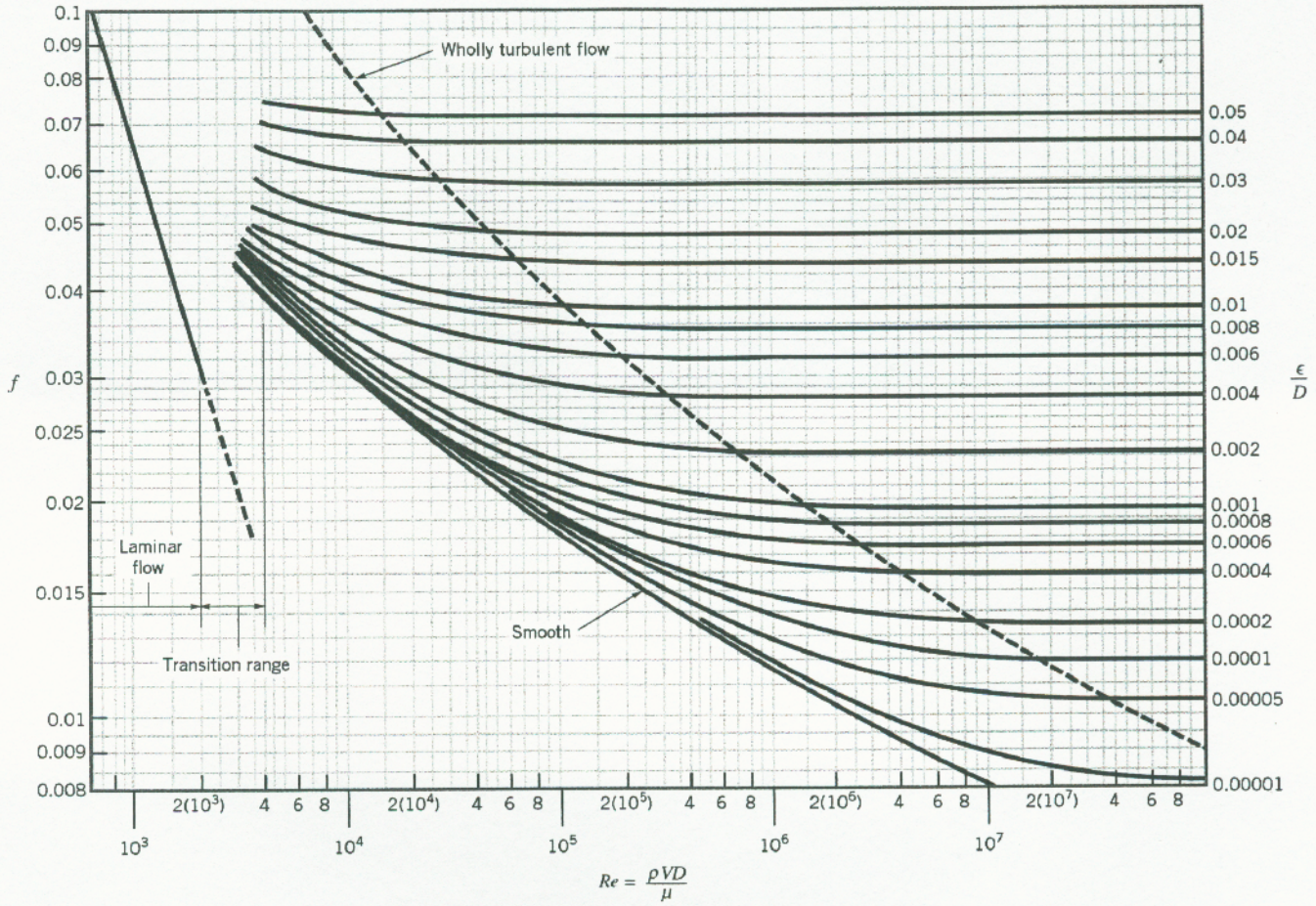


Fig. Problem 5 Moody chart

Empirical Equations for the Flat Plate Drag Coefficient

Equation	Flow Conditions
$C_{Df} = 1.328/(\mathrm{Re}_\ell)^{0.5}$	Laminar flow
$C_{Df} = 0.455/(\log \mathrm{Re}_\ell)^{2.58} - 1700/\mathrm{Re}_\ell$	Transitional with $\mathrm{Re}_{xcr} = 5 \times 10^5$
$C_{Df} = 0.455/(\log \mathrm{Re}_\ell)^{2.58}$	Turbulent, smooth plate
$C_{Df} = [1.89 - 1.62 \log(\varepsilon/\ell)]^{-2.5}$	Completely turbulent

Table Problem 6

Part II:Convection (35%)

7. 15%. A concentrating solar collector has a tube (diameter = 60 mm) at the focal point of a parabolic reflector and pressurized water passing through the tube with inlet temperature of 20 ℃ and flow rate of 0.01 kg/s. Water C_p = 4181 J/kg K, k = 0.67 W/m K, $\mu = 352\times10^{-6}$ N.s/m^2, Pr = 2.2. If uniform heating at the surface of the tube by solar energy with 2000 W/m^2 can be considered,
   (a) what tube length L is required to obtain an exit temperature of 80 ℃? (5%)
   (b) what is the surface temperature at the outlet of the tube where fully-developed conditions may be assumed to exist? (10%)
8. 10%. Forced air at 25℃ and 10 m/s is used to cool electronic elements mounted on a circuit board. Consider a chip of length 4 mm and width 4 mm located 120 mm from the leading edge. The appropriate convection correlation is $\mathrm{Nu}_x = 0.04\ \mathrm{Re}_x^{0.85}\mathrm{Pr}^{0.33}$. Estimate the surface temperature of the chip T_s if its heat dissipation rate is 30 mW. (Air k = 0.027 W/m K, $\nu = 1.69\times10^{-5}$ m^2/s, Pr = 0.7)

國立中山大學100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】

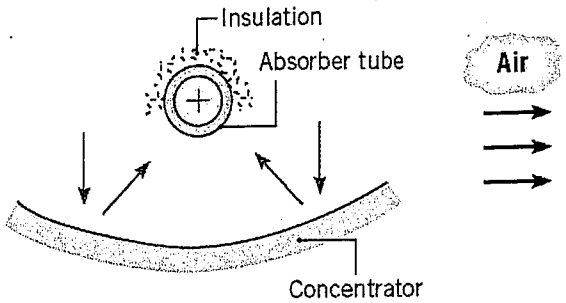


Fig. Problem 7

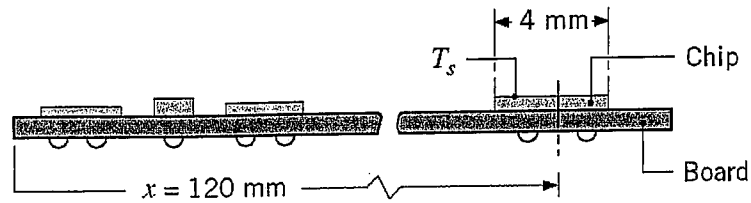


Fig. Problem 8

9. 5%. How to determine if a convection problem is forced convection dominant, free convection dominant, or mixed.
(5%) How to determine if the flow is laminar or turbulent for internal flow, external flow and natural convection flow, respectively.

國立中山大學100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】

第一部份選擇題 50%（以下題目為單選題，每題答對得五分）

(I) A specimen of annealed Titanium having an initial diameter of $d_o = 0.505\ in$ was tested in tension using a gauge length of $\ell_o = 2.000\ in$. A gauge length of $\ell = 2.310$ inch, *i.e.* a cross section area $A = 0.1735\ in^2$, was measured under a tensile load of $P = 14950\ lbf$.

(1) ( ) The engineering stress of the specimen at this load is (A)*74.6 kpsi* (B) *86.2 kpsi* (C) *69.9 kpsi* (D) *98.7 kpsi* (E) *None*

(2) ( ) The true stress of the specimen at this load is (A)*74.6 kpsi* (B) *86.2 kpsi* (C) *69.9 kpsi* (D) *98.7 kpsi* (E) *None*

(3) ( ) The engineering strain of the specimen at this load is (A) *0.1132 in/in* (B) *0.1550 in/in* (C) *0.3057 in/in* (D) *0.4132 in/in* (E) *None*

(4) ( ) The true strain of the specimen at this load is (A) *0.1441 in/in* (B) *0.2548 in/in* (C) *0.3057 in/in* (D) *0.4132 in/in* (E) *None*

(II) A hot-rolled steel specimen has a yield strength of $S_{yt} = S_{yc} = 100\ kpsi$. The Young's modulus and the Poisson's ratio of the steel are $E = 30 \times 10^6\ psi$ and $\upsilon = 0.3$. Estimate the factor of safety for the principal stress states $\sigma_1 = 25\ kpsi, \sigma_2 = 25\ kpsi\ and\ \sigma_3 = -25\ kpsi$

(5) ( ) By using the maximum normal stress theory, the factor of safety is
(A) $n = 0.5$ (B) $n = 1.0$ (C) $n = 2.0$ (D) $n = 4.0$ (E) $n = \infty$

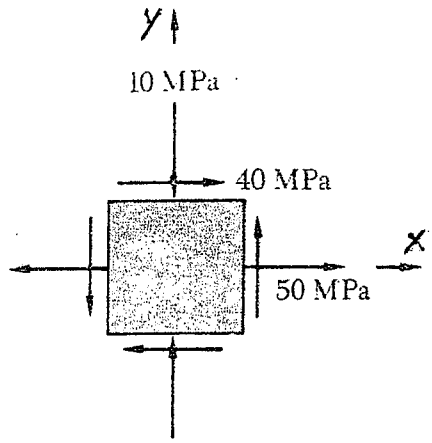
(6) ( ) By using the maximum shear stress theory, the factor of safety is
(A) $n = 0.5$ (B) $n = 1.0$ (C) $n = 2.0$ (D) $n = 4.0$ (E) $n = \infty$

(7) ( ) By using the maximum distortion energy theory, the factor of safety is
(A) $n = 0.5$ (B) $n = 1.0$ (C) $n = 2.0$ (D) $n = 4.0$ (E) $n = \infty$

國立中山大學100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】

(III) For the state of plane stress shown in following figure



(8) ( ) The corresponding stress tensor at a point 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 at this point 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 at this point is

(A) $\tau_{max} = 70.0\ MPa$ (B) $\tau_{max} = 50.0\ MPa$ (C) $\tau_{max} = 40.0\ MPa$

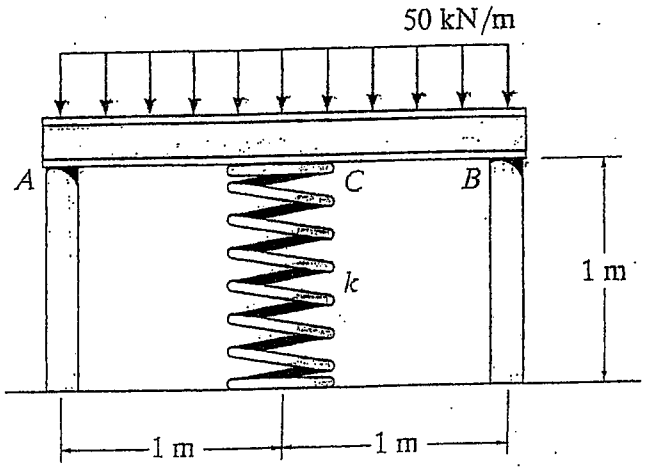
(D) $\tau_{max} = 30.0\ MPa$ (E) None

國立中山大學100學年度碩士班招生考試試題

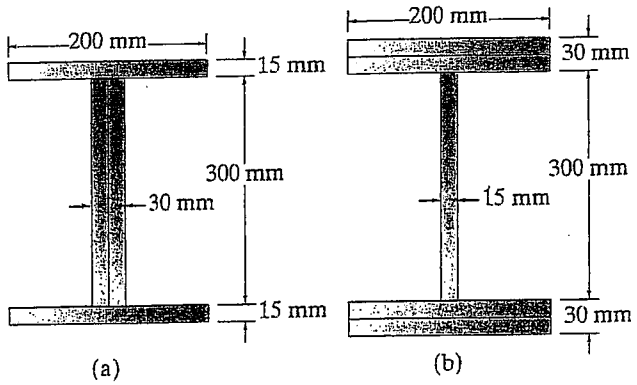
科目：材料力學【機電系碩士班乙組】

第二部份計算題 50%

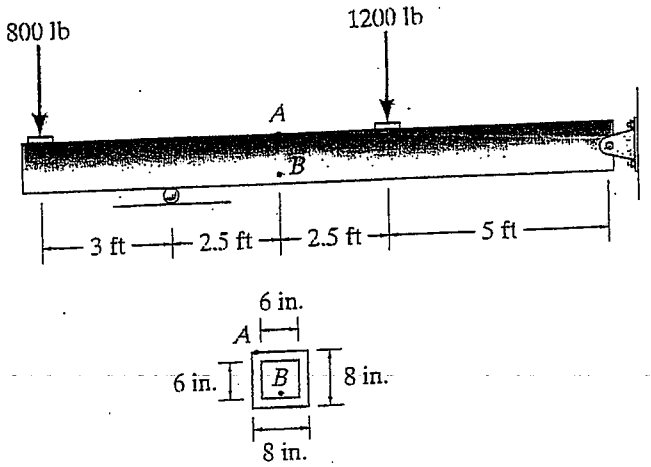
(11) The rigid bar is supported by the two short white spruce wooden posts and a spring. If each of the posts has an unloaded length of *1 m* and a cross-sectional area of *600 mm²*, and the spring has a stiffness of *k = 2 MN/m* and an unstretched length of *1.02 m*, determine the vertical displacement of ***A*** and ***B*** after the load is applied to the bar. (15%)



(12) Two considerations have been proposed for the design of a beam. Determine which one will support a moment of *M = 150 kN-m* with the least amount of bending stress. What is that stress? By what percentage is it more efficient? (15%)



(13) The box beam is subjected to the loading shown. Determine the principal stresses in the beam at points ***A*** and ***B***. (20%)



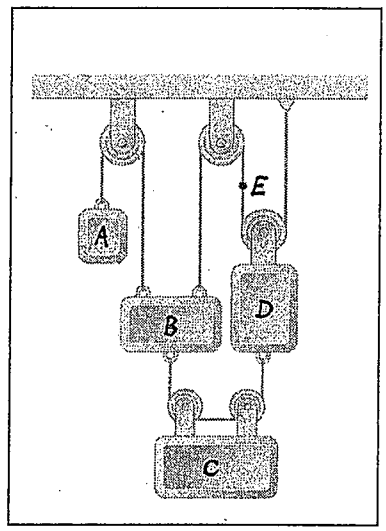
國立中山大學100學年度碩士班招生考試試題

科目：應用力學【機電系碩士班乙組、丙組】

Please choose the correct answers for problem 1 to problem 3

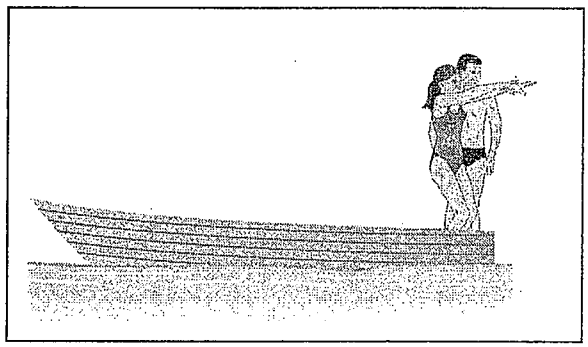
Please be noted that the correct answers for each problem may be more than one

1. Block C starts from rest and moves downward with a constant velocity. Let VA, VB, VC and VD be the velocities of blocks A, B, C and D, respectively. Let downward be the positive direction. Then which of the following statements are correct? (10%)



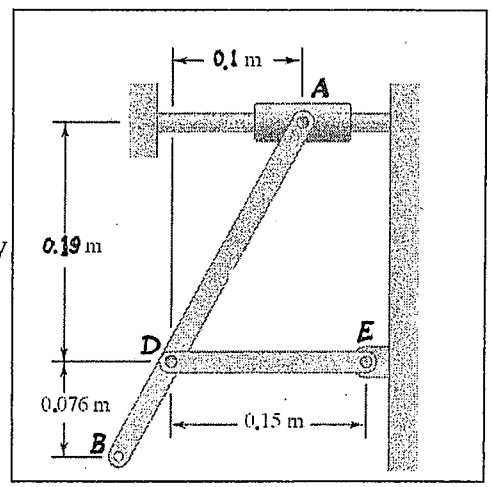
(A) VA = VB.
(B) VA = 2VD.
(C) VA + 4VC = 0.
(D) VB + VD = 2VC
(E) .Let VE be the velocity of portion E of the cable, then VE = VA.
(F) None of the previous statements is correct.

2. A 65.3 kg man and a 43.5 kg woman stand side by side at the same end of a 108.8 kg boat, ready to dive, each with a 4.87 m/s velocity relative to the boat. Neglecting the water resistance. Then which of the following statements are correct? (20%)



(A) If the man dives first, the speed of the boat after the man has dived is between 1.4 m/s to 1.5 m/s.
(B) If the man dives first, the speed of the boat after they have both dived is between 3.9 m/s to 4.1 m/s.
(C) If the woman dives first, the speed of the boat after the. woman has dived is less than 1.5 m/s.
(D) If the woman dives first, the speed of the boat after they have both dived is greater than 4.1 m/s.
(E) If they dive simultaneously, the speed of the boat after they have both dived is less than 4.1 m/s
(F) None of the previous statements is correct

3. Knowing that at the instant shown the velocity of collar A is zero and its acceleration is 0.24 m/s^2 to the left. Which of the following statements are correct? (20%)

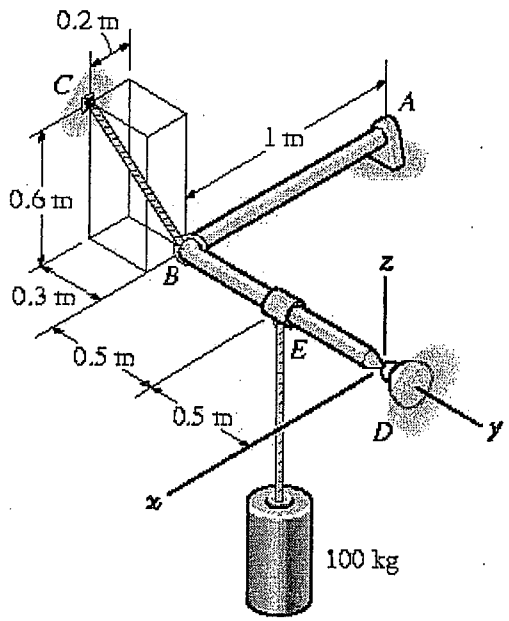


(A) The angular velocity of the bar AB is zero at this instant.
(B) The angular velocity of the bar DE is zero at this instant.
(C) At this instant, the velocity of point D is zero, but the velocity of point B is not zero.
(D) At this instant, the angular accelerations of bar AB is in the counter-clockwise direction, but the angular accelerations of bar DE is in the clockwise directions.
(E) At this instant, the acceleration of point B is zero, but the acceleration of point D is not zero..
(F) None of the previous statements is correct.

國立中山大學100學年度碩士班招生考試試題

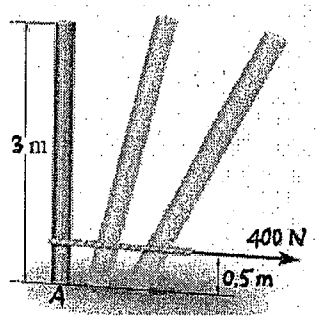
科目：應用力學【機電系碩士班乙組、丙組】

4 The bent rod is supported at A by a journal bearing, at D by a ball and socket joint, and at B by means of cable BC. Using only one equilibrium equation, obtain a direct solution for the tension in cable BC. The bearing at A is capable of exerting force components only in the z and y directions since it is properly aligned. (20%)

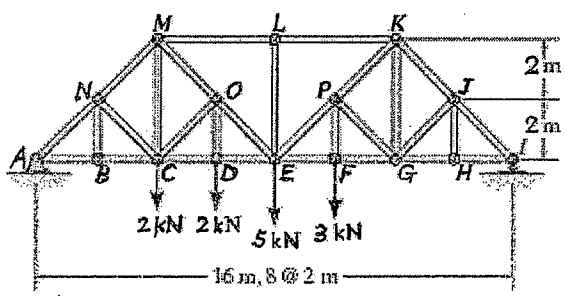


(a)

5. The uniform slender pole has a mass of 100kg. If the coefficients of static and kinetic friction between the end of the pole and the surface are $\mu_s = 0.3$ and $\mu_k = 0.25$ respectively, determine the pole's angular acceleration at the instant the 400N horizontal force is applied. The pole is originally at rest. (20%)



6. Indicate all zero-force members of the Baltimore truss. (10%)



國立中山大學100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. (10%) Obtain the transfer function $E_o(s)/E_i(s)$ of the system shown in Fig. 1.

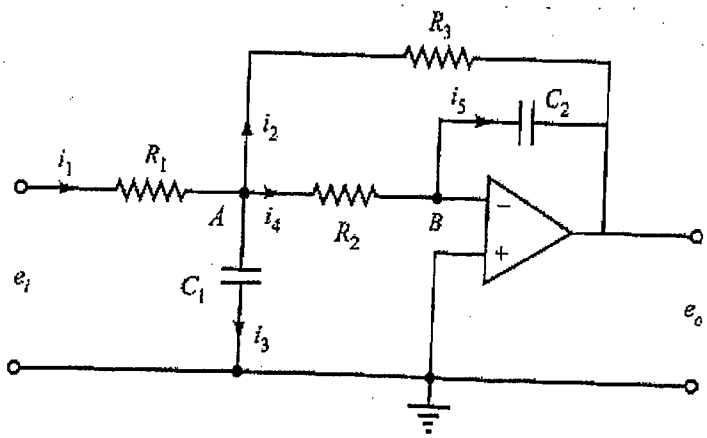


Fig. 1

2. (10%) Consider the feedforward transfer function of a unit-feedback control system $G(s)=\dfrac{(1+ks)}{s(s+1)^2}$. Compute and plot the unit-step response of the closed-loop system for $k=1$. Also find the critical value of k so that the closed-loop system is marginally stable.
3. (10%) Consider a unit-feedback system with the feedforward transfer function $G(s)=\dfrac{(s+1)(s+2)(s+3)}{s^3(s-1)}$, plot root loci for the system.
4. (20%) Consider the system shown in Fig. 2. Determine the value of k such that the damping ratio ζ of the dominant closed poles is 0.5.

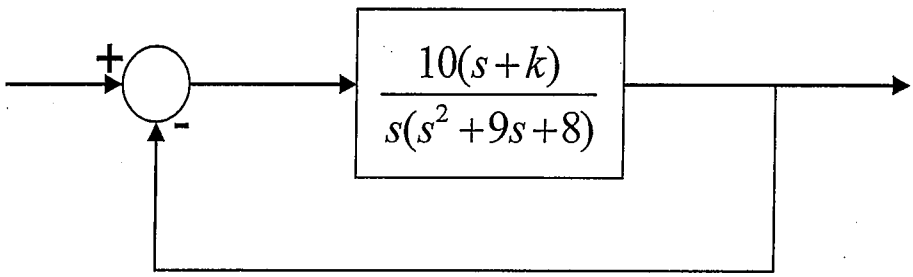


Fig. 2

5. (5%) Consider a unit feedback control system. Please discuss the advantage(s) of designing controller based on the frequency response characteristics of its open loop system.
6. (10%) Consider a unit feedback control system. It is stated that to have an acceptable relative stability the polar plot of its open loop system should be away from the -1 point. Do you agree with this statement? Why?
7. (10%) Please draw the Bode diagram and polar plot of systems with the following transfer functions: (a) $\dfrac{100(1-s)}{s(s+10)}$, and (b) $\dfrac{0.1(s+100)e^{-0.02s}}{(s+1)(s+10)}$.

國立中山大學100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】

8. (10%) It is given the Bode diagrams of two linear dynamic systems as shown in Fig.3. Please guess the possible transfer functions of the systems.

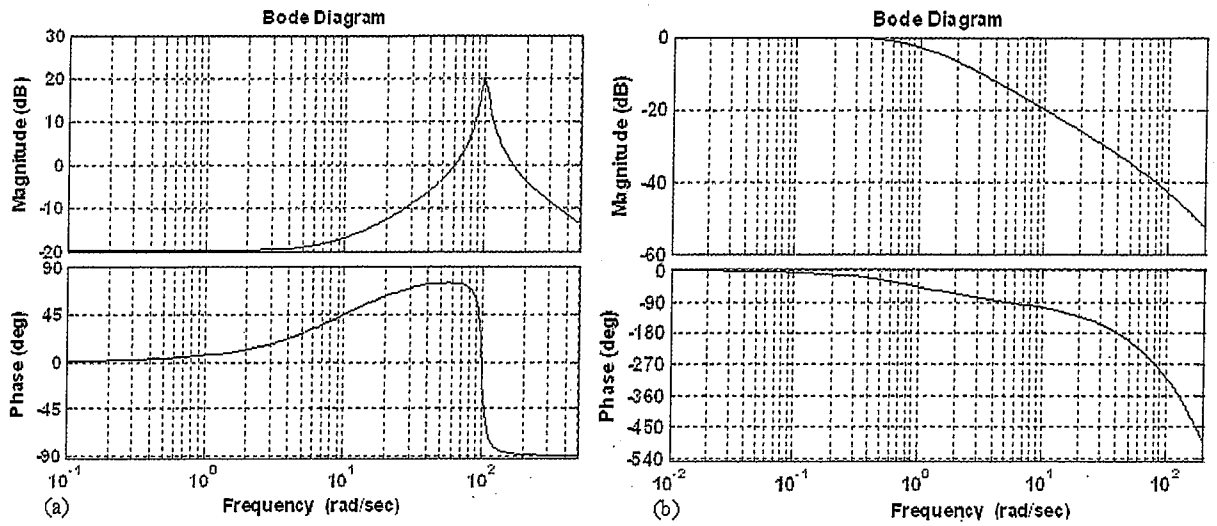


Fig . 3

9. (15%) Consider a unit feedback control system as shown in Fig.4. It is given the polar plot of the controlled system (with transfer function *G(s)*), as indicated in Fig. 5. The locations of $G(j\omega)$ at four different frequencies (0.46, 0.91, 1.76, and 4.01 rad/sec) are denoted by symbol X. Please design a proper controller *C(s)* for this control system to have a good stability and a bandwidth larger than 10 rad/sec. Discuss your design in detail.

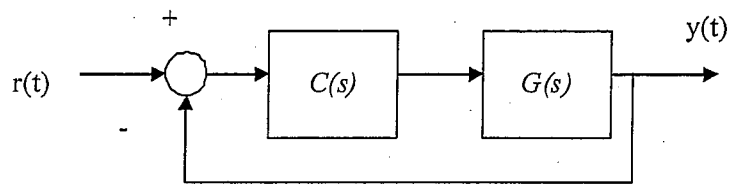


Fig. 4

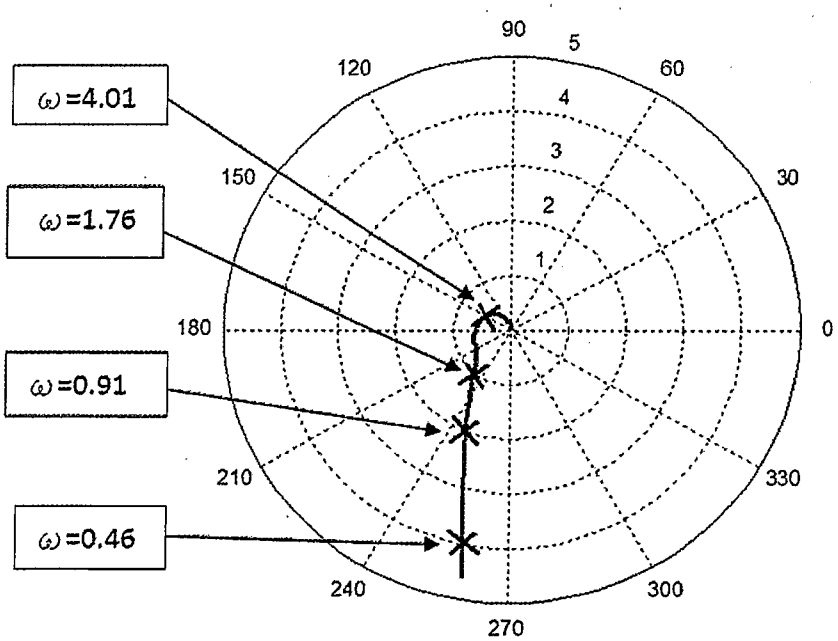


Fig.5

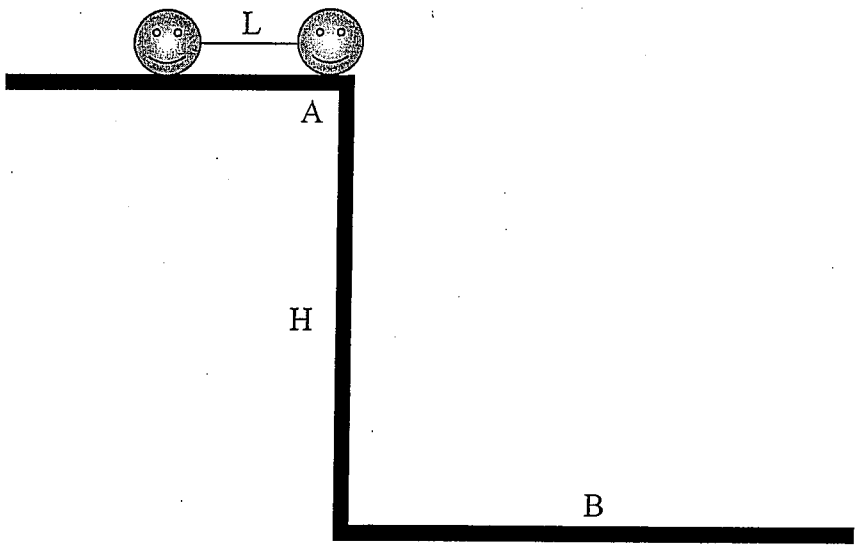
國立中山大學100學年度碩士班招生考試試題

科目：動力學【機電系碩士班丁組、戊組】

第1題到第5題為單選題，請作答於答案卷選擇題答案區。

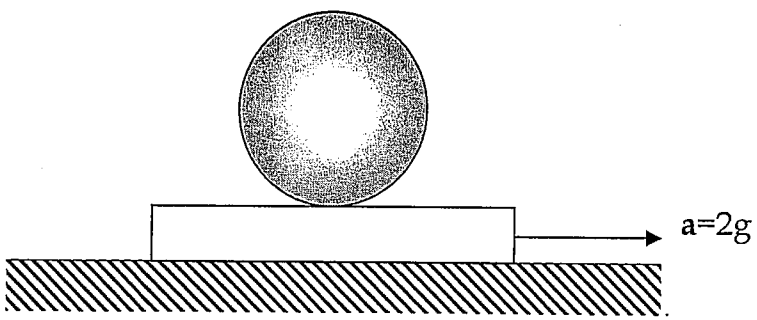
1. Two ice-mountain climbers have just succeeded in climbing up an ice-mountain. And just as the second climber is climbing over the edge of mountain (see point A in the following figure), the two climbers lose their footing and slip down with no friction. Each climber has a mass of M and are joined together by a mass-less inextensible rope of length L. Later both climbers hit the horizontal ground (B in the figure) at the same time. What is the minimum height H of this ice-mountain? (10%)

(a) $(0.4+\pi/4+\pi^2/8)L$, (b) $(0.5+\pi/5+\pi^2/8)L$, (c) $(0.5+\pi/4+\pi^2/7)L$,
(d) $(0.5+\pi/4+\pi^2/9)L$, (e) $(0.3+\pi/6+\pi^2/8)L$, (f) $(0.5+\pi/4+\pi^2/8)L$,
(g) $(0.4+\pi/4+\pi^2/5)L$,



2. A solid sphere is resting on a platform which is given a horizontal acceleration a=2g, as shown in the following figure. Determine the acceleration of the center of the sphere if the coefficient of the friction between the sphere and the platform is 0.8. (10%)

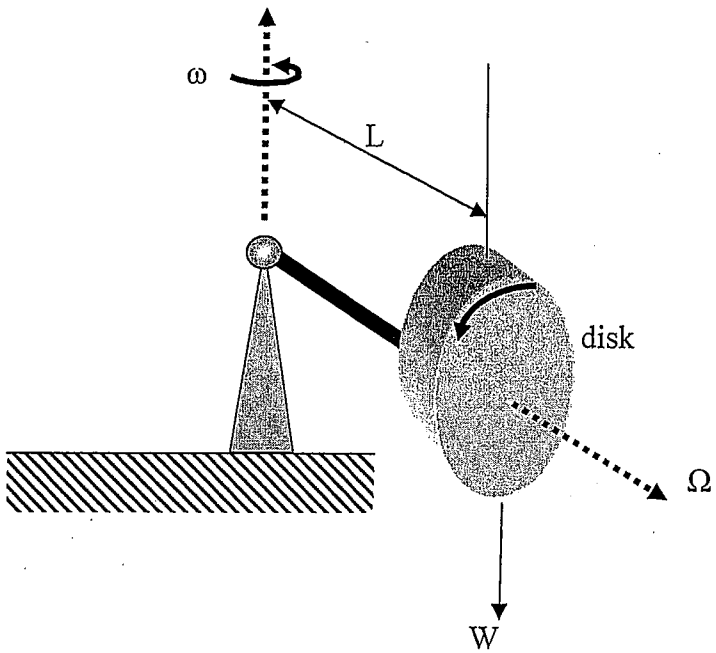
(a) 2g/5, (b) 5g/6, (c) 3g/7, (d) 5g/8, (e) 4g/7, (f) 5g/7, (g) 5g/9,



國立中山大學100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、戊組】

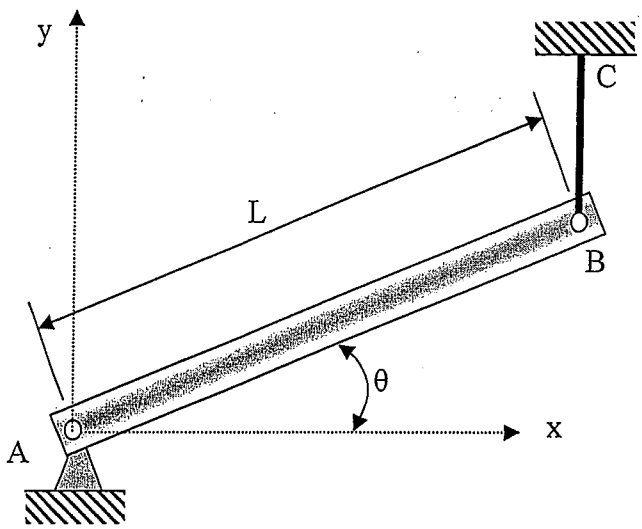
3. A circular disk of moment of inertia **I** (about its geometrical axis) rotates about that axis with an angular velocity **Ω** with respect to the axis. At the same time, the axis itself rotates in a horizontal plane with a precessional angular velocity **ω**. A gravity moment of magnitude **WL** acts on the system as shown in the figure. Compute the precessional velocity **ω** compatible with this steady motion of the system. (10%)



(a) ω=WL/(IΩ), (b) ω=2WL/(IΩ),
(c) ω=3WL/(IΩ), (d) ω=4WL/(IΩ),
(e) ω=WL/(2IΩ), (f) ω=WL/(3IΩ),
(g) ω=WL/(4IΩ),

4. A bar of length **L** with weight **W** is initially pinned at end A and is connected to end C by a wire BC as shown in the following figure. If the bar is released from rest at θ = 60° by cutting the wire BC off, please determine the horizontal reaction force at end A when the bar is at the position of θ = 30°. (10%)

(a) A_x= 0.111W, (b) A_x= 0.121W, (c) A_x= 0.131W, (d) A_x= 0.141W,
(e) A_x= 0.151W, (f) A_x= 0.161W, (g) A_x= 0.171W,



5. Following the above question, the vertical reaction force A_y is: (10%)

(a) A_y= 0.113W, (b) A_y= 0.123W, (c) A_y= 0.133W, (d) A_y= 0.143W, (e) A_y= 0.153W,
(f) A_y= 0.163W, (g) A_y= 0.173W,

國立中山大學100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、戊組】

第6題到第8題，請作答於答案卷。

6. 什麼是簡諧運動 (simple harmonic motion)？試舉一實例並證明該運動真為簡諧運動。(20%)

7. 什麼是剛體的速度瞬心 (instantaneous center of velocity)？試證明它的存在，並說明其用途。(15%)

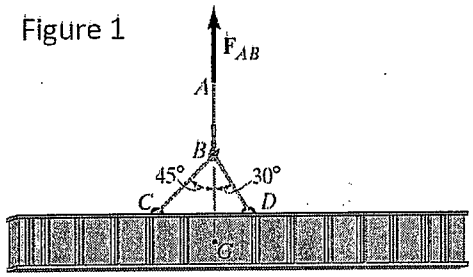
8. **注意：本題需以英文作答！** 簡要說明機械系大學部必修課程『機動學』各項主要課題之內容。(Explain concisely in English the key contents of "Kinematics," a required course for college students majoring in Mechanical Engineering.) (15%)

國立中山大學100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、戊組】

1. Refer to Figure 1. If the mass of the girder is M and its center of mass is located at point *G*, please answer the following problems.

Figure 1



(a) Draw the free body diagram. (5%)

(b) If M is 3000 kg, determine the tension developed in cables AB, BC, and BD for equilibrium. (5%)

(c) If cables BD and BC can withstand a maximum tensile force of 20 kN, determine the maximum mass of the girder that can be suspended from cable AB so that neither cable will fail. (5%)

2. A pulley system was set as shown in Figure 2.

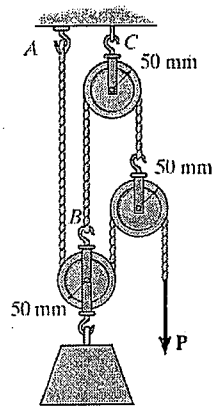


Figure 2

(a) Determine the force P need to support the 50-kg weight if the pulley is weightless. (5%)

(b) Determine the force P needed to support the 50-kg weight if each pulley has a weight of 50 N. (5%)

3. Two blocks *A* and *B* are resting on the incline for which the coefficients of static friction are $\mu_A = 0.15$ and $\mu_B = 0.25$. The spring has a stiffness of k = 40 N/m and is originally unstretched. If block A and B have a weight of 10 kg and 6 kg, respectively.

(a) Determine the angle which will cause motion of one of the blocks. (5%)

(b) What is the friction force under each of the blocks when this occurs? (5%)

(c) What is the answer for problem (a) if block A and B have a weight of 6 kg and 10 kg, respectively. (5%)

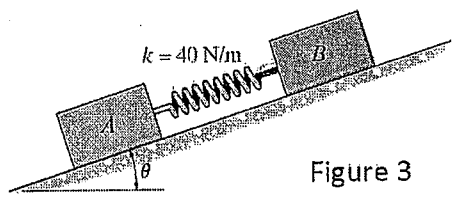


Figure 3

4. Please refer to Figure 4. When the forces are applied to the handles of the bottle opener,

(a) Draw the free body diagram. (5%)

(b) Determine the pulling force developed on the cork. (5%)

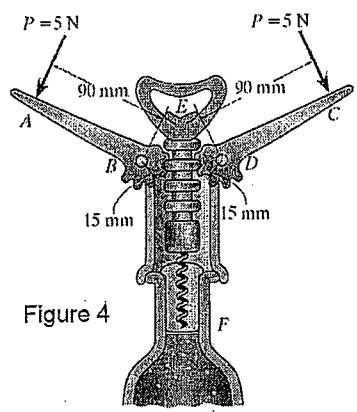


Figure 4

國立中山大學100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、戊組】

5. Refer to Figure 5. This device raises a load W by extending the hydraulic actuator DE. The bars AD and BC are 1.2 m long, and the distances b = 0.75 m and h = 0.45 m. If W = 1500 kN, what force must the hydraulic actuator exert to hold the load in equilibrium? (15%)
6. Refer to Figure 6. The Howe truss helps support a roof. Members AB, BC, CD, DE, EF, and FG have equal length. Model the supports at A and G as roller supports. Use the method of joints to determine the axial forces in members BC, CD, CI, and CJ. (20%)

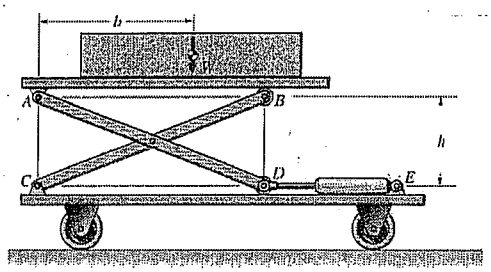


Figure 5

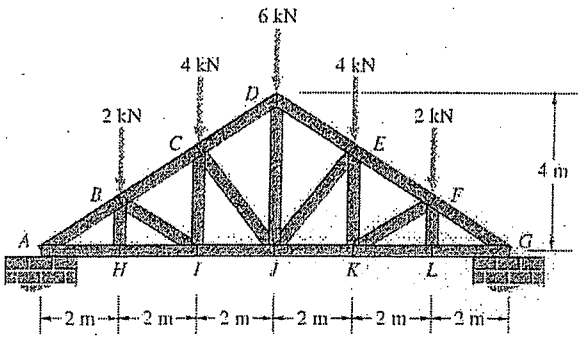


Figure 6

7. Refer to Figure 7. The hydraulic cylinder C exerts a horizontal force at A, raising the weight W. Determine the magnitude of the force the hydraulic cylinder must exert to support the weight in terms of W and α. (15%)

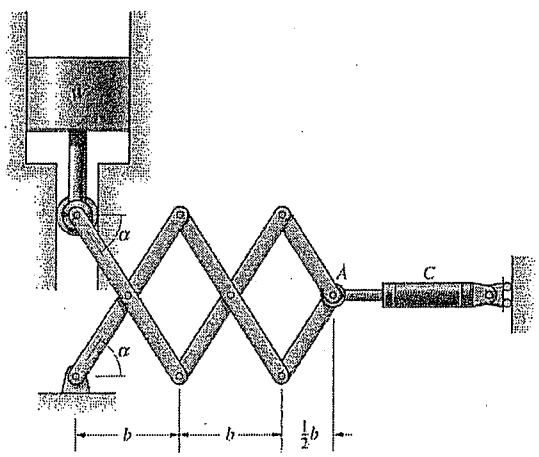


Figure 7