

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學【機電系碩士班乙組、丙組】

題號：438001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）

共 1 頁 第 1 頁

1. (15%) Solve the IVP:  $y'' + 6y' + 9y = e^{-x}\cos 2x$ ,  $y(0) = 1, y'(0) = -1$ .
  - (a) Find the general solution  $y_h = c_1y_1 + c_2y_2$ . (5%)
  - (b) Show the independence of  $y_1$  and  $y_2$ . (5%)
  - (c) Find the particular solution. (5%)
  
2. (25 %) Each of the two tanks contains 200 gal of water, where initially 100 lb (tank  $T_1$ ) and 200 lb (tank  $T_2$ ) of salt are dissolved. The inflow, circulation, and outflow are shown in Fig. 1. The mixture is kept uniform by stirring.

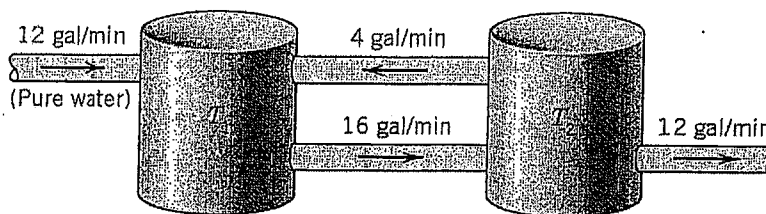


Fig. 1

- (a) Set up the model. (5%)
  - (b) Solve the system. (10%)
  - (c) Type of critical point and its stability. (5%)
  - (d) What will happen if  $t$  tends to infinity? (5%)
  
3. (10%) Find the Inverse Laplace Transform of  $\frac{4(e^{-2s} - 2e^{-5s})}{s^2 + 4}$ .
  
4. (8%) Find the volume of a parallelepiped, as shown in Fig. 2, determined by the three edge vectors:  $\mathbf{a} = [2, 1, 5]$ ,  $\mathbf{b} = [1, 4, 3]$ ,  $\mathbf{c} = [4, 5, 1]$ .

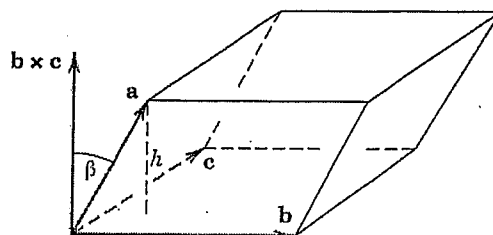


Fig. 2

5. (8%) Find the tangential acceleration and normal acceleration of the motion given by  $\mathbf{r}(t) = \left[ \sin t, \cos t, \frac{1}{2}t^2 \right]$  ( $t = \text{time}$ ).
  
6. (10%) Evaluate the surface integral  $\iint_S \mathbf{F} \cdot \mathbf{n} \, dA$ , where  $\mathbf{F} = [xy, yz, zx]$  and  $S$  is the surface of the cone  $x^2 + y^2 \leq 4z^2$ ,  $0 \leq z \leq 3$ .
  
7. (10%) Evaluate the surface integral:  $\iint_S (\text{curl } \mathbf{F}) \cdot \mathbf{n} \, dA$ , where  $\mathbf{F} = [y^3, -x^3, 0]$ ,  $S: x^2 + y^2 \leq 1, z = 0$ .
  
8. (14%) Solve the partial differential equation:  $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$  with the boundary conditions:  $\frac{\partial u}{\partial x}(0, t) = 0$  and  $\frac{\partial u}{\partial x}(L, t) = 0$  (for all  $t \geq 0$ ) and the initial condition:  $u(x, 0) = \cos \frac{2\pi}{L}x$ .

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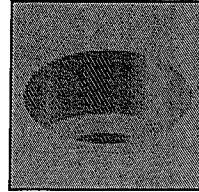
科目名稱：科技英文【機電系碩士班戊組】

題號：438002

※本科目依簡章規定「不可以」使用計算機(混合題)

共 3 頁第 1 頁

I. 選擇題 You are to choose the word, phrase or selection that best completes the sentence or meets the meaning of the condition. Then, on your answer sheet, find the number of the question and mark your answer. (30% in total, 3% each, 單選, 共 30 分, 每題 3 分, 請劃記於答案卡上)



1. Provide the name for the right hand side drawing.  
(a) Boss, (b) Lug, (c) Counterbore, (d) Chamfer.
2. ( ) is a measure of the stiffness of a solid material. It is a mechanical property of linear elastic solid materials. (a) Young's modulus, (b) Strain, (c) Shear modulus, (d) Stress.
3. Photolithography is used in microfabrication because (a) we need to take a photograph of the microdevice, (b) to create patterns in microscale on substrates, (c) to create pictures in microscale, (d) none of the above.
4. ( ) is the mathematical study of continuous change. It has two major branches differential and integral calculus. (a) Calculus, (b) Finite element, (c) Vector, (d) Series.
5. What is not included in mechanics? (a) Dynamics, (b) Acoustics, (c) Hydraulics, (d) Material science.

According to below figure, choose adequate selections.

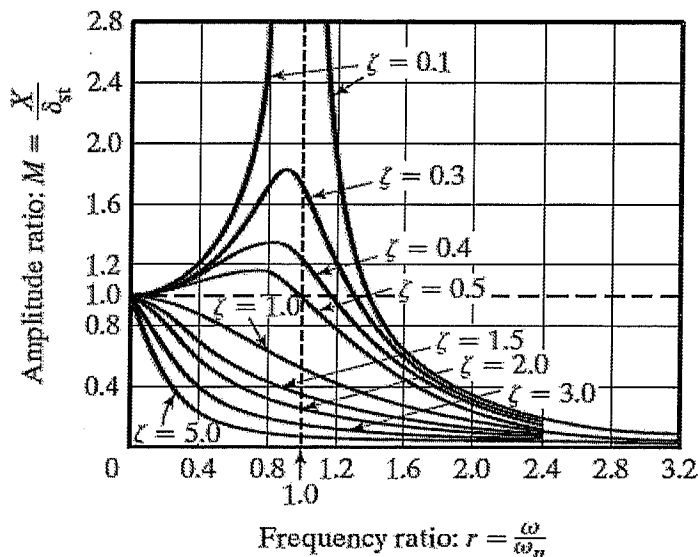


Figure for no. 6 to 8.

6. Any amount of damping ratio ( $\zeta$ ) ( ) the magnification factor ( $M$ ) for all values of the forcing frequency. (a) enhances, (b) increases, (c) induces, (d) reduces.
7. For any ( ) value of  $r$ , a higher value of  $\zeta$  reduces the value of  $M$ . (a) unknown, (b) specified, (c) significant, (d) variation.
8. The reduction in  $M$  in the ( ) of damping ratio is very significant at  $r = 1$ . (a) relevance, (b)

試題隨卷繳回

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：科技英文【機電系碩士班戊組】

題號：438002

※本科目依簡章規定「不可以」使用計算機(混合題)

共 3 頁第 2 頁

providence, (c) presence, (d) vibration.

Read this article and chose adequate selections.

Academic research papers are typically broken down into five sections: abstract, introduction, materials and methods, results, and discussion. A few journals have slightly different formats due to their space constraints or target audience. Each part of the paper serves a unique purpose and can help your research project in a different way.

The abstract provides a summary of the paper. It usually highlights the main content that the authors investigated, shows the key methods of their research, and gives an overview of the authors' conclusions. Reading the abstract will help you decide if the article was what you were looking for, or not, without spending a long time reading the whole paper. Abstracts are usually accessible for free either online at journals' websites or in scientific literature databases.

The introduction gives background information about the topic of the paper, and sets out the specific questions to be addressed by the authors. The quantity and thoroughness of the background information will depend on both the authors' proclivities. Throughout the introduction, there will be citations for previously published articles or reviews that discuss the same topic. Reading the introduction is a test of whether or not you are ready to read the rest of the paper; if the introduction doesn't make sense to you, then the rest of the paper won't either.

9. Where readers can find abstracts? (a) brochures, (b) manuals, (c) journal's websites or databases, (d) newspapers.

10. Which section provides citations for readers to refer to additional background reading? (a) abstract, (b) introduction, (c) summary, (d) discussion.

II. 中翻英 Chinese-English Translation. 參考以下中文內容，將中文內容翻譯成英文，寫於答案紙上。(共 28 分，每題 7 分) Translate the following Chinese passages into English passages. Write your answer on the answer sheet. (28 % in total, 7 % each)

1. 是什麼因素導致智慧型手機大受歡迎呢？也許其成功的主要原因在於他容易與便利操作。(7 %)

2. 基於前述的研究目的，本研究所探討的四組主要研究問題如下。(7 %)

3. 黃銅是由兩種金屬，鋅和銅所組成的合金。(7 %)

4. 儘管這些問題的研究仍在起步的階段，其結果將會在幾個領域上有廣泛意涵(implications)。(7 %)

III. 英翻中 English-Chinese Translation. (共 32 分，每題 8 分)。參考以下英文內容，於答案紙上作答。 Translate the following English passages into Chinese passages. Write your answer on the answer sheet. (32% in total, 8% each)

1. The ANOVA indicates a significant main effect for proficiency ( $F = 10.46, P = 0.002$ ). However, no significant main effect for grade level ( $F = 1.49, P = 0.23$ ) and no significant interaction effect proficiency-by grade level ( $F = 2.03, P = 0.14$ ) were found.

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：科技英文【機電系碩士班戊組】

題號：438002

※本科目依簡章規定「不可以」使用計算機(混合題)

共 3 頁第 3 頁

2. Mathematically this error has a magnitude equal to the product of the lever arm's length and the sine of the angle. If errors in parallax are to be avoided, the measuring system must be placed coaxially with the axis along which displacement is to be measured on the workpiece.

3. Various measurements must be made in order to evaluate these error motions. The data that is collected is typically analyzed with the aid of different types of polar plots because linear plots of the data are often difficult to interpret.

4. Associated with these issues about the ontological status of space and time was the question of the nature of true motion. Newton defined the true motion of a body to be its motion through absolute space. Those who, before or shortly after Newton, rejected the reality of space, did not necessarily deny that there is a fact of the matter as to the state of true motion of any given body.

IV. 以英文簡答下列文章中相關之問題。每題5分，共10分。Answer below questions in English. (10% in total, 5% each)

The Wright brothers read about these relatively primitive aircraft and realized none had suitable controls. They hoped that they could learn more about Flight Dynamics by watching birds in flight. The Wrights watched vultures, eagles and hawks maneuver with their wings in unstable air. Wilbur's favorite was the vulture, because it soared more than other birds. In physical terms, a soaring bird is able to achieve a perfect balance of the physical forces of lift, drift and gravity. Wilbur came to the conclusion that birds balance themselves in flight by adjusting the shape of their wings. In order to maintain what we call "lateral control", the Wrights would have first to change the shape of the wing.

There were three basic dimensions needed to control an aircraft. Of these three dimension, the first type of control needed in flight is for pitch. Pitch controls the up-and-down movement of the nose; in other words, pitch is what allows an aircraft to descend or climb. The second type of control needed is for yaw. Yaw control allows the craft's nose to turn right or left, providing the aircraft's directional control.

1. According to above paragraph, why Wright brothers interest in bird observation?

2. The third type of needed control is roll. Describe the possible motion of roll and its purpose.

The End

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：基礎熱傳學【機電系碩士班甲組】

題號：438003

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）

共 2 頁第 1 頁

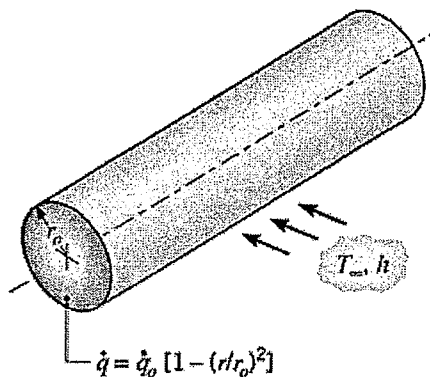
1.(5%) What is the major difference between thermodynamics and heat transfer?

2.(15%) Please illustrate the physical principles of the three modes of heat transfer conduction, convection, and radiation, respectively. Please also write down the rate equations of the three modes, respectively.

3.(20%) A glass window of width  $W = 1$  m and height  $H = 2$  m is 5 mm thick and has a thermal conductivity of  $k_g = 1.4$  W/m·K. If the inner and outer surface temperatures of the glass are  $15^\circ\text{C}$  and  $-20^\circ\text{C}$ , respectively, on a cold winter day, what is the rate of heat loss through the glass? To reduce heat loss through windows, it is customary to use a double pane construction in which adjoining panes are separated by an air space. If the spacing is 10 mm and the inner and outer surface temperatures of the double pane window remain the same as single pane window, what is the rate of heat loss from this double pane window? The thermal conductivity of air is  $k_a = 0.024$  W/m·K.

4.(20%) The free convection heat transfer coefficient on a thin hot vertical plate suspended in still air can be determined from observations of the change in plate temperature with time as it cools. Assuming the plate is isothermal and radiation exchange with its surroundings is negligible, evaluate the convection coefficient at the instant of time when the plate temperature is  $250^\circ\text{C}$  and the change in plate temperature with time ( $dT/dt$ ) is  $-0.028$  K/s. The ambient air temperature is  $25^\circ\text{C}$  and the plate measures  $0.4 \times 0.4$  m with a mass of 4.5 kg and a specific heat of 2770 J/kg·K.

5.(20%) Radioactive wastes are packed in a long, thin-walled cylindrical container. The wastes generate thermal energy nonuniformly according to the relation  $\dot{q} = \dot{q}_0[1 - (r/r_0)^2]$ , where  $\dot{q}$  is the local rate of energy generation per unit volume,  $\dot{q}_0$  is a constant, and  $r_0$  is the radius of the container. Steady-state conditions are maintained by submerging the container in a liquid that is at  $T_\infty$ , and provides a uniform convection coefficient  $h$ . Obtain an expression for the total rate at which energy is generated in a unit length of the container. Use this result to obtain an expression for the temperature  $T_s$  of the container wall.



國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：基礎熱傳學【機電系碩士班甲組】

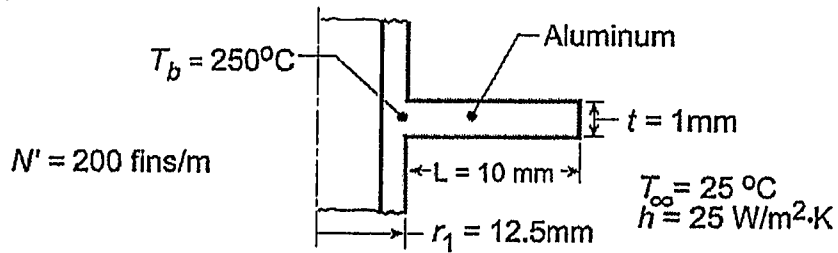
題號：438003

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 2 頁

6.(20%) an annular aluminum fin of rectangular profile is attached to a circular tube having an outside diameter of 25 mm and a surface temperature of  $250^{\circ}\text{C}$ . The fin is 1 mm thick and 10 mm long, and the temperature and the convection coefficient associated with the adjoining fluid are  $25^{\circ}\text{C}$  and  $25 \text{ W/m}^2\cdot\text{K}$ , respectively. (Assume that the fin effectiveness is 97%.)

(a) What is the heat loss per fin?(10%)

(b) If 200 such fins are spaced at 5-mm increments along the tube length, what is the heat loss per meter of tube length? (10%)



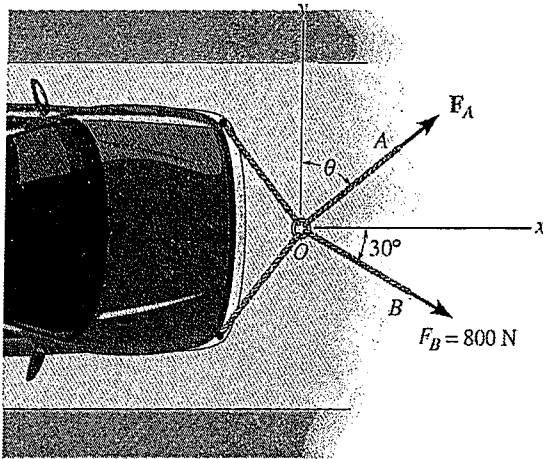
國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：靜力學【機電系碩士班丁組】

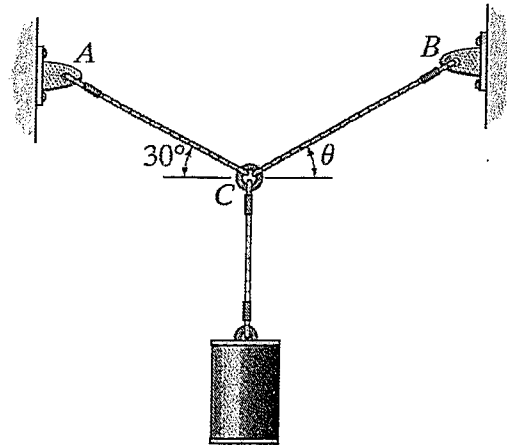
題號：438004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 1 頁

1. 如圖一所示(Figure 1)，Determine the magnitude and direction  $\theta$  of  $F_A$  so that the resultant force is directed along the positive  $x$  axis and has a magnitude of 1250 N. (10%)
2. 如圖二所示(Figure 2)，Determine the tension developed in wires  $CA$  and  $CB$  required for equilibrium of the 10-kg cylinder. Take  $\theta=40^\circ$ . (10%)

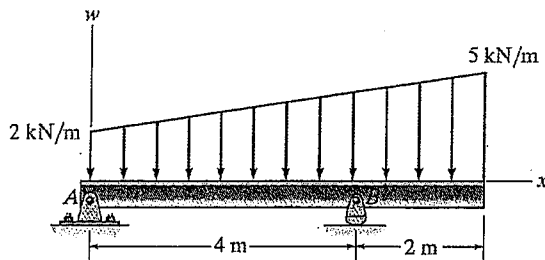


圖一 (Figure 1)

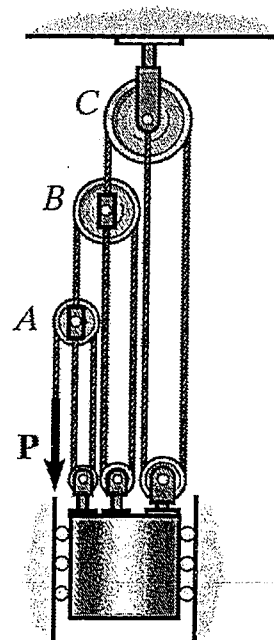


圖二 (Figure 2)

3. 如圖三所示(Figure 3)，Replace the loading by an equivalent resultant force and specify its location on the beam, measured from point  $A$ . (10%)
4. 如圖四所示(Figure 4)，Determine the force  $P$  required to hold the 50-kg mass in equilibrium. (10%)



圖三 (Figure 3)



圖四 (Figure 4)

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：靜力學【機電系碩士班丁組】

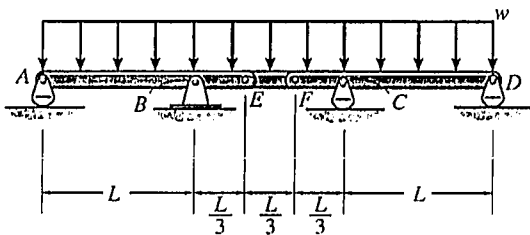
題號：438004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）

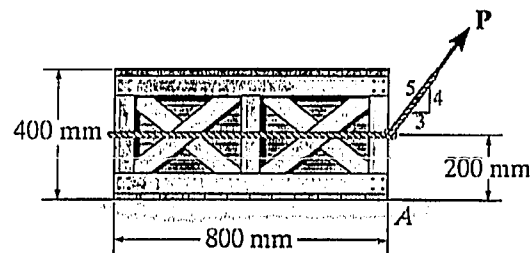
共 2 頁 第 2 頁

5. 如圖五所示(Figure 5)，Draw the shear and moment diagrams for the compound beam. The beam is pin connected at  $E$  and  $F$ . (20%)

6. 如圖六所示(Figure 6)，Determine the friction force on the 40-kg crate, and the resultant normal force and its position  $x$ , measured from point  $A$ , if the force is  $P=300$  N. Take  $\mu_s=0.5$  and  $\mu_k=0.2$ . (20%)

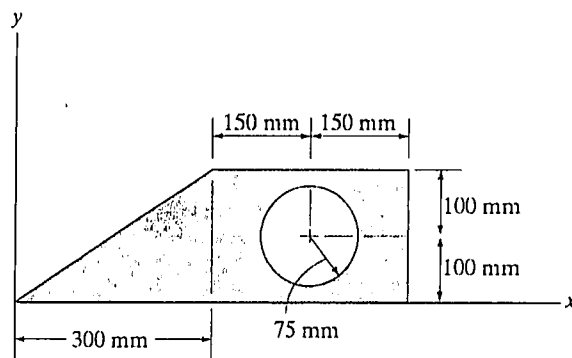


圖五 (Figure 5)



圖六 (Figure 6)

7. 如圖七所示(Figure 7)，Determine the moment of inertia of the composite area about the  $x$  axis, and determine the moment of inertia of the composite area about the  $y$  axis. (20%)



圖七 (Figure 7)



# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：自動控制【機電系碩士班丙組】

題號：438005

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 1 頁第 1 頁

以下均為簡答題，只要簡明的回答我們所提出的問題重點即可，真的不需要長篇大論

1. (8%) Briefly describe the relationship between phase margin and time delay.
2. (8%) Briefly describe the relationship between impulse response and transfer function model of a linear system.
3. (8%) How do you compare the speed-of-response of two linear systems from their impulse responses?
4. (8%) How do you experimentally determine the frequency response of a linear system?
5. (8%) This problem considers systems
$$m\ddot{x} + c\dot{x} + kx = f(t) \text{ and } m\ddot{x} + c\dot{x} + kx = f'(t) + f(t)$$
Which system has larger overshoot? Why.
6. (8%) If I told you that, compared to open-loop system, one of advantages of the closed-loop systems is that the closed-loop system can more effectively tolerate measurement noise than the open-loop system. Would you agree? Why or why not?
7. (8%) After increasing the bandwidth of his closed-loop system design, John discovers that he has successfully reduced the time constant of the system. Encouraged by this success, John believes that he can make the time constant of the closed-loop system even smaller by further increasing the bandwidth of the closed-loop system. If this logic is correct, John can increase the speed of the system without limitation. Apparently, this is physically impossible. Why?
8. (8%) A linear time-invariant system is a linear system whose parameters do not change with time. What is the most important property of such a system?
9. (8%) Why does PI (proportional-integral) controller more popular than PID (proportional-integral-derivative) controller in industry control applications?
10. (8%) You are told not to perform pole-zero cancellation for an unstable system. What is the reason behind this advice?
11. (10%) How do you determine a system is a linear or a nonlinear system?
12. (10%) Given the Bode plots of the two separate linear stable systems whose transfer functions are  $G_1$  and  $G_2$ , respectively, how do you determine the Bode plot for the two systems in series connection?

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：材料力學【機電系碩士班乙組】

題號：438006

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 1 頁第 1 頁

## Prob. #1 (40%)

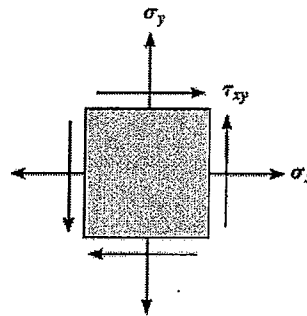
- (1) Plot the engineering and true stress-strain diagrams for a ductile material. (10%, 不必依照比例，並請標出圖上各個區域的名稱以及相對應的應力名稱，錯一個扣一分，扣至 10 分為止)
- (2) 以中文解釋（或回答）下列名詞（或問題）(30%)
  - (a) Homogeneous and isotropic material (2%)
  - (b) The gauge-length (1%) (可圖示)
  - (c) Statically indeterminate problem (2%)
  - (d) Offset method (2%) (可圖示)
  - (e) Modulus of resilience (2%) (解釋加圖示)
  - (f) Modulus of toughness (2%) (解釋加圖示)
  - (g) The conventional and true stress and strain (2%) (可直接用公式回答)
  - (h) Saint-Venant's Principle (2%)
  - (i) Hooke's law (2%) (解釋加公式)
  - (j) Factor of safety (2%) (必須顯示所有公式)
  - (k) Poisson's ratio (2%) (公式及其範圍)
  - (l) General state of stress (9%, 請畫出來並標示之，錯一個扣一分，扣至 9 分為止)

## Prob. #2 (30%)

Draw the Mohr's circle according to the given stress state and prove that:

$$\tan 2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

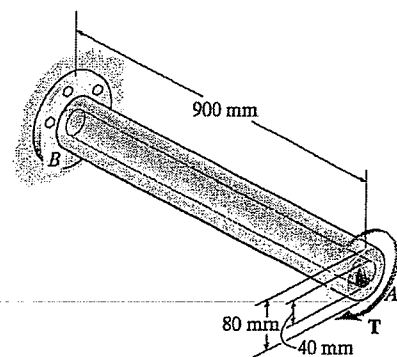
$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$



Where  $\theta_p$  is the plane of maximum normal stress and  $\sigma_{1,2}$  are the principal stresses.

## Prob. #3 (30%)

The Am1004-T61 magnesium tube is bonded to the A-36 steel rod. If a torque of  $T = 5 \text{ kN}\cdot\text{m}$  is applied to end A, determine the maximum shear stress in each material. Sketch the shear stress distribution.  $G_{st} = 75 \text{ GPa}$  and  $G_{mg} = 18 \text{ GPa}$ .



國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：動力學【機電系碩士班丁組】

題號：438007

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 1 頁

- The motion of a particle is defined by the relation  $x = 2t^3 - 9t^2 + 12t + 10$ , where  $x$  and  $t$  are expressed in meters and seconds, respectively. Determine the time, the position, and the acceleration of the particle when the velocity  $v = 0$ . (20%)
- The acceleration of a package sliding at Point  $A$  is  $3 \text{ m/s}^2$ . Assuming that the coefficient of kinetic friction is the same for each section, determine the acceleration of the package at Point  $B$ . (As shown in Fig. P2) (20%)

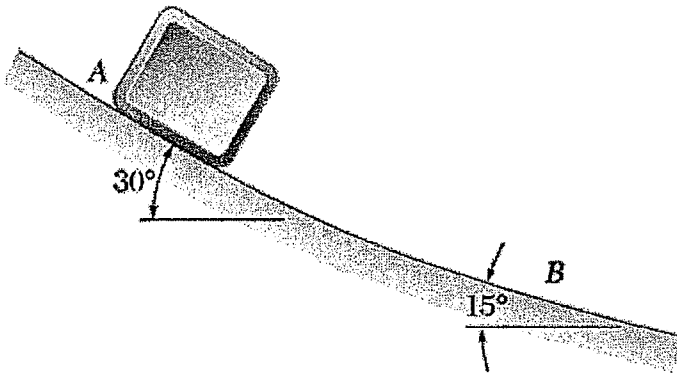


Fig. P2

- A spring is used to stop a 60-kg package which is sliding on a horizontal surface. The spring has a constant  $k = 20 \text{ kN/m}$  and is held by cables so that it is initially compressed 120 mm. Knowing that the package has a velocity of  $2.5 \text{ m/s}$  in the position shown and that the maximum additional deflection of the spring is 40 mm, determine (a) the coefficient of kinetic friction between the package and the surface, (b) the velocity of the package as it passes again through the position shown. (Hint: 本小題問package經spring彈回後經Fig. P3所示之位置之速度). (As shown in Fig. P3) (20%)

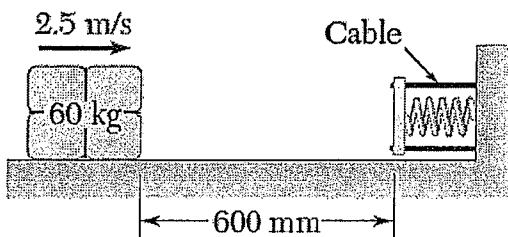


Fig. P3

- A small grinding wheel is attached to the shaft of an electric motor which has a rated speed of 3600 rpm. When the power is turned on, the unit reaches its rated speed in 5 s, and when the power is turned off, the unit coasts to rest in 70 s. Assuming uniformly accelerated motion, determine the number of revolutions that the motor executes (a) in reaching its rated speed, (b) in coasting to rest. (20%)
- Knowing that at the instant shown the velocity of collar  $D$  is  $1.6 \text{ m/s}$  upward, determine (a) the angular velocity of rod  $AD$ , (b) the velocity of Point  $B$ , (c) the velocity of Point  $A$ . (As shown in Fig. P5) (20%)

試題隨卷繳回

背面有題

國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：動力學【機電系碩士班丁組】

題號：438007

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 2 頁

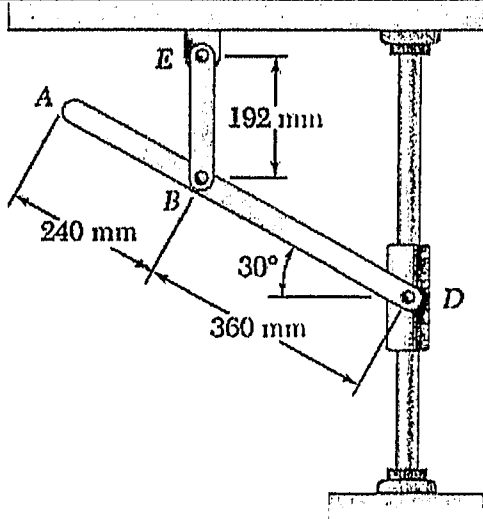


Fig. P5

# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

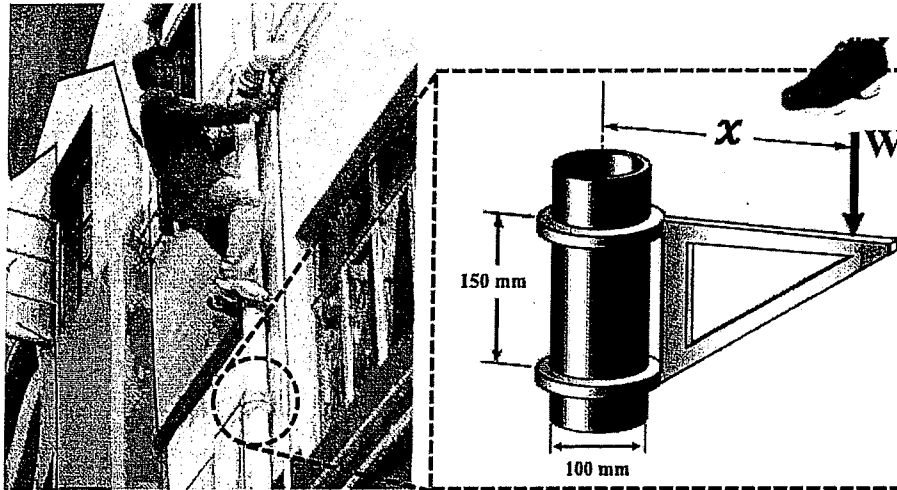
科目名稱：應用力學(含靜力學及動力學)【機電系碩士班乙組】

題號：438008

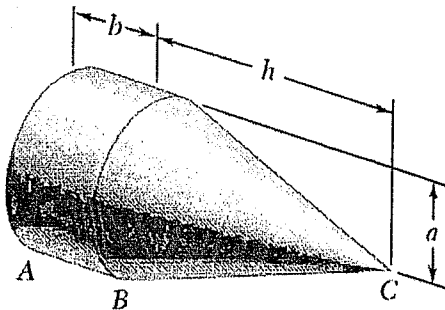
※本科目依簡章規定「可以」使用計算機(廠牌、功能不拘)(問答申論題)

共 3 頁第 1 頁

Q1. Jacky Chen would like to rescue his friend and has to enter the house via the window. He needs to safely stand on a movable bracket, as shown in Fig, firstly. So could you please **determine the minimum distance  $x$**  at which the load can be supported for his weight  $W$ ? The movable bracket is placed on the 100-mm diameter pipe. The coefficient of friction between the pipe and bracket is 0.25 and the weight of the bracket can be neglected. (15%)

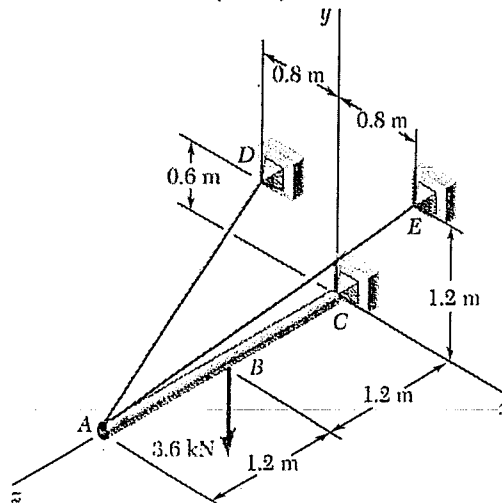


Q2. Please **determine the location of the centroid of the composite body.** (15%)



	$V$	$\bar{x}$	$\bar{x}V$
Cylinder I		$\frac{1}{2}b$	
Cone II	$\frac{1}{3}\pi a^2 h$		

Q3. A 2.4-m boom is held by a ball-and-socket joint at C and by two cables AE and AD. **Determine the tension in the cable AE and the reaction at C.** (20%)



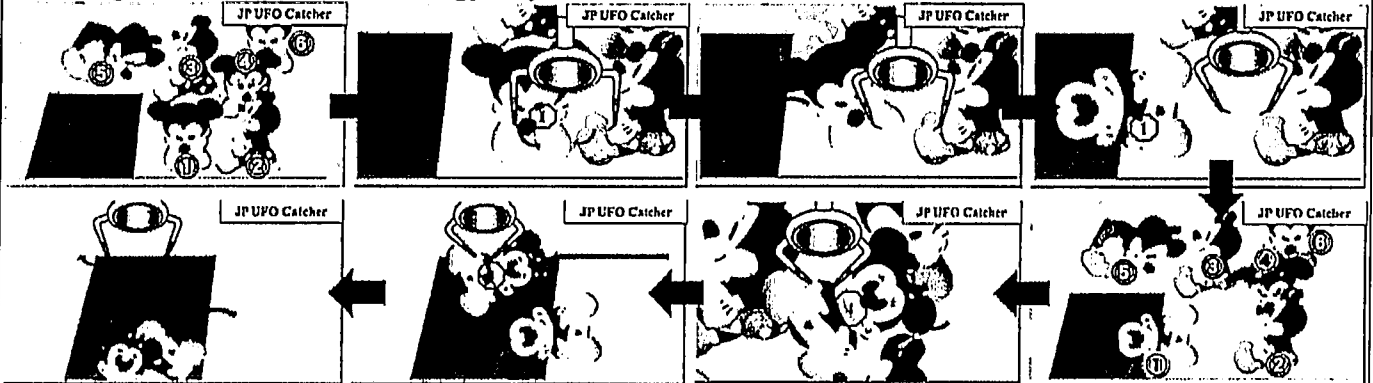
# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：應用力學(含靜力學及動力學)【機電系碩士班乙組】

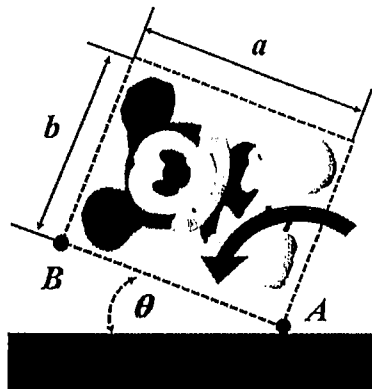
題號：438008

※本科目依簡章規定「可以」使用計算機(廠牌、功能不拘)(問答申論題) 共3頁第2頁

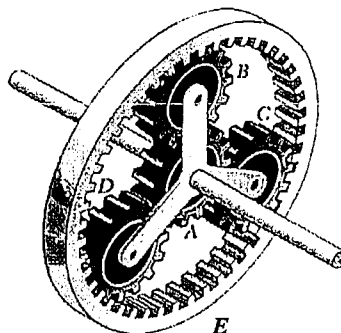
Q4. You are a team member to participate in the International UFO Catcher Competition 2018 in Japan. You have to get the Minnie and Mickey Mouse dolls to win the championship. The following procedures in the figure below show the strategy of your team.



Assuming the Mickey Mouse doll is a uniformly loaded rectangular box and released from rest in the position as shown below. The surface of the table is sufficiently rough to prevent slipping in the Mickey Mouse. Please **determine (a) the smallest value of the ratio  $a/b$  of the Mickey Mouse for which point A will remain in contact with the table.** (Hint; Assuming the impact at B is perfectly soft contact and Mickey is fully laid down on a full table. At that instant, the velocities must be zero and the reaction at corner A must be zero. Please use the principle of impulse and momentum to calculate the smallest value of the ratio  $a/b$ .) (15%)



Q5. In the planetary gear system shown, the radius of gears A, B, C, and D is 30 mm and the radius of the outer gear E is 90 mm. Knowing that gear E has an angular velocity of 180 rpm clockwise and that the central gear A has an angular velocity of 240 rpm clockwise, **determine the angular velocity of the spider connecting the planetary gears.** (20%)



# 國立中山大學 107 學年度碩士暨碩士專班招生考試試題

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題號：438008

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Q6. In a game of pool, ball A is moving with a velocity  $V_0$  when it strikes balls B and C, which are at rest and aligned as shown. Knowing that after the collision the three balls move in the directions indicated, and that  $V_0 = 7 \text{ m/s}$  and  $V_C = 3 \text{ m/s}$ , determine the magnitude of the velocity of ball B. (15%)

