國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：基礎熱傳學【機電系碩士班甲組】

－作答注意事項－

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
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- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

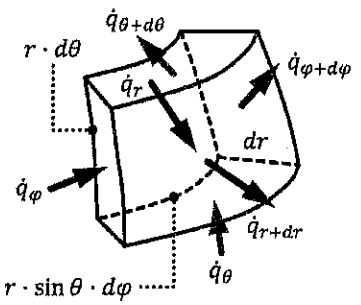
國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

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）　　

Question 1 **(10 points)**

Given a differential element cut out of a spherical shell. Starting with an energy balance, as well as the Fourier's Law, derive the heat diffusion equation in spherical coordinate system. Assume isotropic and homogeneous medium and a constant volumetric internal heat generation rate be $\dot{q}'''_g$.



Question 2 **(30 points)**

Consider a thin rectangular plate in the domain $\{(x, y) \mid 0 \le x \le \alpha\,;\, 0 \le y \le \beta\}$. The top edge at $y = \beta$ is subjected to a constant heat flux $\dot{q}''_s$. The temperatures at all other edges are kept constant at T_0.

a) Write down the governing partial differential equation for steady-state conduction in the slab with the associated boundary conditions. (6 points)

b) Let $\theta^* = \dfrac{T - T_0}{\dfrac{\dot{q}''_s \cdot \alpha}{k}}$, $x^* = \dfrac{x}{\alpha}$, $y^* = \dfrac{y}{\alpha}$. Rewrite the governing equation and the boundary conditions in *part a)* in non-dimensional form. Must show all steps for points. (8 points)

c) Prove that, the series expansion solution to the steady state temperature distribution is given by,

$$\theta(x, y) = \sum_{n=1}^{\infty} C_n \cdot \sin(n \cdot \pi \cdot x) \cdot \sinh(n \cdot \pi \cdot x),$$

where C_n is given by, $C_n = -2 \cdot \left[\dfrac{1 - (-1)^n}{(n \cdot \pi)^2 \cdot \cosh\left(n \cdot \pi \cdot \dfrac{\beta}{\alpha}\right)} \right]$. (16 points)

Question 3 **(30 points)**

A cylinder of diameter 0.025 m and length of 0.2 m, with an opaque and diffuse surface, is placed in a fan-assisted oven. The walls of the oven are at 1000 K. The cylinder is exposed to quiescent hot air at 750 K in the oven. The surface emissivity of the cylinder is given as,

$$\varepsilon_\lambda = \begin{cases} \varepsilon_1 = 0.8 & 0 \le \lambda < 4\ \mu\text{m} \\ \varepsilon_2 = 0.2 & 4\ \mu\text{m} \le \lambda \le \infty \end{cases}$$

Assume the initial temperature of the cylinder be 300 K.

a) Find the initial total, hemispherical emissivity, and absorptivity of the cylinder. (9 points)

b) Calculate the convective heat transfer coefficient of the cylinder surface initially. (6 points)

c) Evaluate the net rate of heat transfer initially. (6 points)

d) Determine the steady-state temperature on the cylinder surface. Evaluate air properties at the film temperature of 862.5 K. (9 points)

Question 4 **(10 points)**

Given a brand new concentric tube heat exchanger with smooth walls, the outer cylinder has a diameter of 0.04 m and inner cylinder with diameter of 0.03 m. The length of the heat exchanger is 9 m. Air is flowing in the space between the inner and outer tubes with mass flow rate of 0.05 kg/s and enters the heat exchanger at temperature of 245 K and pressure of 1 MPa. Condensing steam is flowing in the inner tube at 110 kPa . Assume the heat exchanger assembly is perfectly insulated.

a) Find the averaged heat transfer coefficient. (7 points)

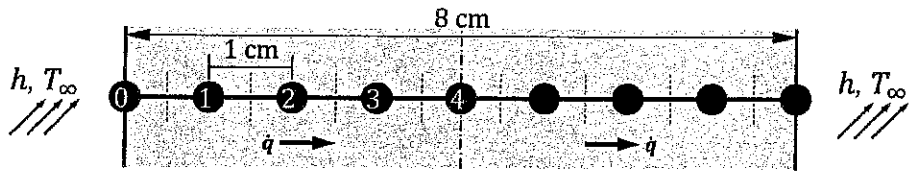
b) Calculate the outlet temperature of the air stream. (3 points)

Question 5 **(10 points)**

Consider a thick slab of soda lime glass with thickness of 8 cm, initially at 573 K. It is subject to cooling by air at 303 K, blowing across its surface with a velocity of 25 m/s. Assume the slab of glass is 2 m long. For properties evaluation, assume the surface temperature of the glass be 317 K.

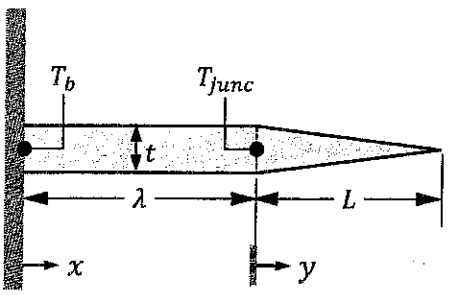
a) Derive the transient finite difference equations for nodes 0 to 4, using an explicit scheme. (3 points)

b) Determine the largest possible time-step sizes such that the explicit scheme will not become unstable upon iteration. (7 points)



Question 6 **(10 points)**

Fins are being installed outside a chimney with the surface temperature at T_b. The fin consists a rectangular portion, which is protruding with a length of λ from the chimney wall. It has another fin with triangular cross-section that further extends for another length of L from the end of the rectangular fin. The fin surface is subjected to convective cooling by air at T_∞ and the heat transfer coefficient is estimated as h and its thermal conductivity to be k. Assume the width to be W.



a) Prove that the temperature distribution and heat transfer rate in the rectangular portion are given by,

$$T(x) = T_\infty + (T_\lambda - T_\infty)\cdot\frac{\sinh(\beta\cdot x)}{\sinh(\beta\cdot\lambda)} + (T_b - T_\infty)\cdot\frac{\sinh(\beta\cdot(\lambda - x))}{\sinh(\beta\cdot\lambda)}$$

and $$\dot{q}(x) = -k\cdot(t\cdot W)\cdot\beta\cdot\left[(T_\lambda - T_e)\cdot\frac{\cosh(\beta\cdot x)}{\sinh(\beta\cdot\lambda)} + (T_b - T_e)\cdot\frac{\cosh(\beta\cdot(\lambda - x))}{\sinh(\beta\cdot\lambda)}\right].$$

where $\beta^2 = \dfrac{2\cdot h}{k\cdot t}$ and $T_\lambda = T(x=\lambda)$. (6 points)

b) Prove that the temperature at the junction, $T_{junc} = T_\lambda$, is given by,

$$T_{junc} = \frac{T_b}{\sinh(\beta\cdot\lambda)\cdot\eta_{fin}\cdot\beta\cdot L + \cosh(\beta\cdot\lambda)},$$

where η_{fin} is the fin efficiency. (4 points)

Appendix
Selected material properties

Property	Material	Temperature	Value
Density, ρ	Water		1000 kg/m^3
	Air	268.5 K (1 atm)	1.2 kg/m^3
	Air	310 K (1 MPa)	11.41 kg/m^3
	Air	356.5 K (1 atm)	0.9902 kg/m^3
Viscosity, ν	Water		1.5×10^{-6} m^2/s
	Air	268.5 K	1.298×10^{-5} m^2/s
	Air	310 K	1.654×10^{-5} m^2/s
	Air	356.5 K	2.131×10^{-5} m^2/s
	Air	525 K	4.114×10^{-5} m^2/s
	Air	862.5 K	9.326×10^{-5} m^2/s
Thermal Diffusivity, α	Air	268.5 K	1.765×10^{-5} m^2/s
Prandtl Number, Pr	Air	268.5 K	0.7355
	Air	310 K	0.7252
	Air	356.5 K	0.7151
	Air	525 K	0.6953
	Air	862.5 K	0.7031
Specific Heat, C_p	Water		4200 J/kg·K
	Air		1005 J/kg·K
Saturation Temperature, T_{sat}	Water	**at 110 kPa**	375.3 K
Thermal Conductivity, k	Water		0.6 W/m·K
	Air	268.5 K	0.02328 W/m·K
	Air	310 K	0.02740 W/m·K
	Air	356.5 K	0.02977 W/m·K
	Air	525 K	0.04116 W/m·K
	Air	862.5 K	0.06039 W/m·K

Correlations for Nusselt Numbers

- Cylinder with external cross flow:

$$\overline{Nu}_D = 0.3 + \frac{0.62 \cdot Re_D^{1/2} \cdot Pr^{1/3}}{\left[1+\left(\frac{0.4}{Pr}\right)^{2/3}\right]^{1/4}} \cdot \left[1+\left(\frac{Re_D}{282000}\right)^{5/8}\right]^{4/5}$$

- Fully developed laminar flow with uniform surface temperature: $\overline{Nu}_D = 3.66$
- Fully developed laminar flow with uniform surface heat flux: $\overline{Nu}_D = 4.36$
- Mixed boundary layer over a flat plate,

$$\overline{Nu}_L = \left[0.037 \cdot Re_L^{4/5} - 871\right] \cdot Pr^{1/3} \qquad \text{for} \qquad Ra_D \le 10^{12}$$

- Long, horizontal cylinder in quiescent ambient,

$$\overline{Nu}_D = \left\{ 0.6 + \frac{0.387 \cdot Ra_D^{1/6}}{\left[1 + \left(\frac{0.559}{Pr}\right)^{9/16}\right]^{8/27}} \right\}^2 \quad \text{for} \quad Ra_D \le 10^{12}.$$

- Fully developed turbulent flow, $\overline{Nu}_D = \dfrac{\frac{f}{8} \cdot (Re_D - 1000) \cdot Pr}{1 + 12.7 \cdot \left(\frac{f}{8}\right)^{1/2} \cdot (Pr^{2/3} - 1)}$

  - where the friction factor, f, is given by,

$$\frac{1}{\sqrt{f}} = \begin{cases} -2.0 \cdot \log\left(\dfrac{\varepsilon / D}{3.7} + \dfrac{2.51}{Re_D \cdot \sqrt{f}}\right) & \text{for rough wall} \\ 0.790 \cdot \ln(Re_D) - 1.64 & \text{for smooth wall} \end{cases}$$

Heat Exchangers Effectiveness Correlations

- Parallel Flow:

$$\varepsilon = \frac{1 - \exp\left[-NTU \cdot (1 + C_r)\right]}{1 + C_r}$$

- Counter Flow:

$$\varepsilon = \frac{1 - \exp\left[-NTU \cdot (1 - C_r)\right]}{1 - C_r \cdot \exp\left[-NTU \cdot (1 - C_r)\right]} \quad \text{for} \quad C_r < 1$$

$$\varepsilon = \frac{NTU}{1 + NTU} \quad \text{for} \quad C_r = 1$$

Heat Exchangers NTU Correlations

- Parallel Flow:

$$NTU = -\frac{\ln\left[1 - \varepsilon \cdot (1 + C_r)\right]}{1 + C_r}$$

- Counter Flow:

$$NTU = \frac{1}{C_r - 1} \cdot \ln\left(\frac{\varepsilon - 1}{\varepsilon \cdot C_r - 1}\right) \quad \text{for} \quad C_r < 1$$

$$NTU = \frac{\varepsilon}{1 - \varepsilon} \quad \text{for} \quad C_r = 1$$

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：靜力學【機電系碩士班丁組】

—作答注意事項—

考試時間：100分鐘

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國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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）　　

1. Please determine the magnitude ϕ in Fig 1? (10%)

2. Calculate the required tension in cables BA and BC to support the 60-kg cylinder shown in Figure 2. (10%)

3. If the angle θ is 45 degrees, calculate the moment generated by the 4-kN force around point A as depicted in Figure 3. (8%)

4. Calculate the reaction forces acting on the smooth, uniform bar with a mass of 20 kg, as shown in Figure 4. (8%)

5. In Figure 5, the cart is holding a uniform crate with a mass of 85 kg. Calculate the vertical reaction forces at the three casters located at points A, B, and C. Note that the caster at B is not visible in the figure. Assume the mass of the cart itself is negligible. (8%)

6. Calculate the forces exerted by the pins at points A and B on the two-member frame as depicted in Figure 6. (8%)

7. Calculate the moment at point F on the beam as shown in Figure 7. (8%)

8. In Figure 8, a 45-kg disk is placed on a surface with a static friction coefficient of μ_A=0.2. Calculate the maximum couple moment M that can be applied to the bar without initiating motion. (8%)

9. Determine the location of the centroid for the plate area depicted in Figure 9. (8%)

10. Calculate the moment of inertia around the x-axis as shown in Figure 10. (8%)

11. Calculate the moment of inertia of the equilateral triangle around the x' axis that passes through its centroid, as depicted in Figure 11. (8%)

12. Determine the coordinates $\bar{x}$ and $\bar{y}$ for the centroid C of the beam's cross-sectional area shown in Figure 12, and then calculate the product of inertia with respect to the $x'$and y'axes. (8%)

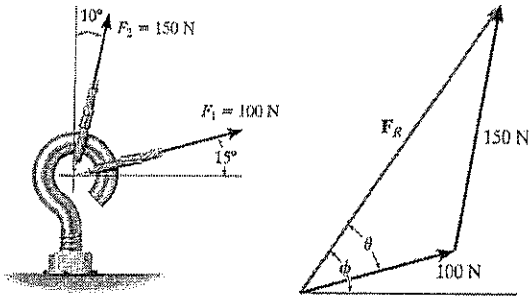

Fig. 1

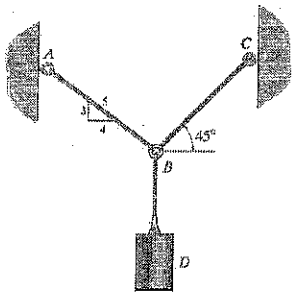

Fig. 2

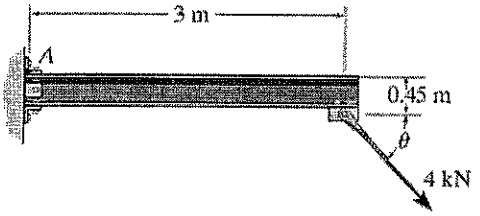

Fig. 3

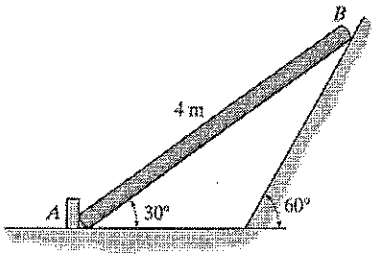

Fig. 4

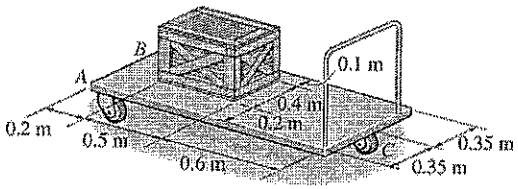

Fig. 5

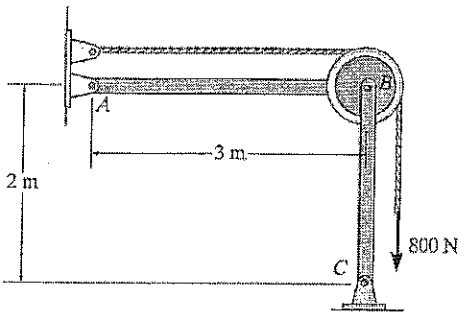

Fig. 6

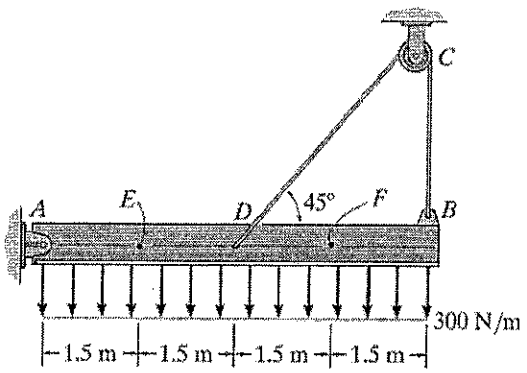

Fig. 7

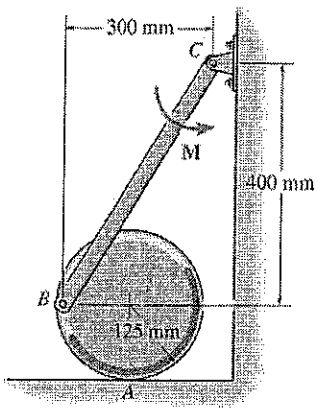

Fig. 8

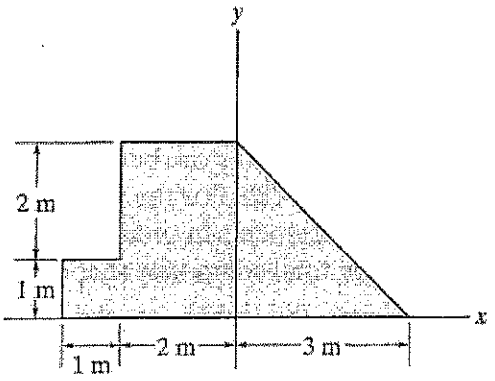

Fig. 9

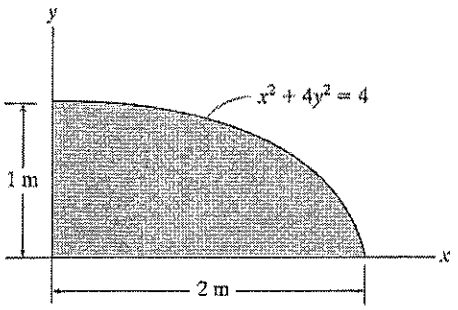

Fig. 10

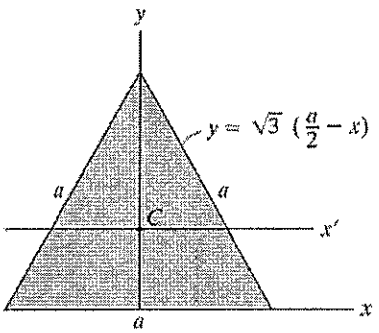

Fig. 11

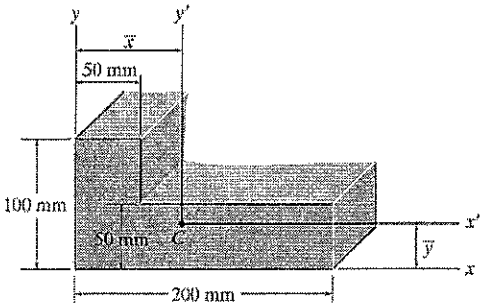

Fig. 12

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碩士班暨碩士在職專班招生考試試題

科目名稱：工程數學【機電系碩士班乙組、丙組】

—作答注意事項—

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國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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）　　

1. Find the general solution of equation:

(a) $x^2\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 4y = 5\cos 2x$ (10%)

(b) $x\frac{dy}{dx} - y + 2y^2 = 2x^2$ (10%)

2. For the following given functions, you are required to:

(a) Sketch the function. (5%)

(b) Express the function in terms of unit step function. (5%)

(c) Determine its Laplace Transformation. (5%)

$$f(t)=\begin{cases} \pi/3 & for \quad 0 \le t < 2\pi \\ 0 & for \quad 2\pi \le t < 4\pi \\ 2\pi \sin 4t & for \quad 4\pi \le t \end{cases}$$

3. From the given matrix **A**, find:

(a) rank(**A**) (5%)

(b) det(**A**) (5%)

(c) $\mathbf{A}^{-1}$ (5%)

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & -2 & -1 \\ 2 & 1 & -3 & 1 \\ -2 & 4 & 1 & 2 \\ 0 & 2 & 0 & 2 \end{bmatrix}$$

4. The vibrating string can be modeled by one-dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2\frac{\partial^2 u}{\partial x^2}$. Consider a plastic string of length $L = \pi$ with fixed ends and $c^2 = 1$. It initially has zero displacement and the following velocity:

$$u_t(x,0) = \begin{cases} u_t(x,0) = 0.01x, & \text{if } 0 \le x \le \frac{1}{2}\pi \\ u_t(x,0) = 0.01(\pi - x), & \text{if } \frac{1}{2}\pi \le x \le \pi \end{cases}$$

Find the displacement $u(x,t)$ of the string. (15%)

5. Given a vector function **F**, solve the following questions.

(a) Show that $\mathbf{F} = (y^2\cos x + z^3)\,\mathbf{i} + (2y\sin x - 4)\,\mathbf{j} + (3xz^2 + 2)\mathbf{k}$ is a conservative field. (5%)

(b) Evaluate the scalar potential for **F**. [Hint: Path Independence Theorem] (10%)

(c) Evaluate the work done in moving an object in this field from $(1,1,-1)$ to $(\pi/2,-1,2)$. (10%)

6. Evaluate the flux integral for the given data.

$\mathbf{F} = [5x, y^3, 0]$, $S: \mathbf{r} = [u, v, 6u - 9v]$, $0 \le u \le 2$, $-1 \le v \le 1$. (10%)

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：科技英文【機電系碩士班戊組】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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)　　

I 單一選擇題 Multiple choice question (40%, 5% each)

請仔細閱讀下列問題，選出最適合空格處之唯一選項，並將答案劃記於答案卡上

1. Which of the following mechanical property describes the resistance of a solid to elastic deformation? (A) Young's modulus, (B) strain, (C) stress, (D) fracture toughness

2. Photolithography is used extensively in semiconductor fabrication, due to its ability to (A) take photograph of the micro-device, (B) create microscale patterns on the silicon substrates, (C) coat silicon substrate with protective coating, (D) none of the above

3. Which of the follow metal is non-ferrous: (A) copper, (B) steel, (C) cast iron, (D) austenitic steel

4. Additive manufacturing (AM) is a rapid prototyping manufacturing process, which of the following is not considered to be its strength? (A) minimise material waste, (B) less shape limitation, (C) improved mechanical strength, (D) lower overall cost (raw material + process)

5. What is the unit of strain? (A) unitless, (B) N/m, (C) m, (D) N/m^2

6. Silicon carbide is a very promising semiconductor material for the applications of power electronics. What is the chemical formula of silicon carbide? (A) SiCa, (B) SiC, (C) CSi, (D) SC

7. One femtometer is _____ meter (A) 10^{15}, (B) 10^{-12}, (C) 10^{-15}, (D) 10^{-9}

8. What is the crystal structure of the alpha-phase titanium? (A) body-center cubic, (B) hexagonal closed-pack, (C) simple cubic, (D) face-center cubic

II 中翻英 Chinese-to-English translation (20%)

參考以下中文內容，將中文內容翻譯成英文，寫於答案紙上。

1. 青銅是由銅和錫所組成的合金，比純銅的機械強度高且熔點較低 (10%)

2. 金屬 3D 列印通常是使用高功率雷射來燒融金屬粉末，並透過載粉盤的移動和鋪粉來將物件層層燒融成型，因此也為一種積層製造之技術 (10%)

III 英翻中 English-to-Chinese translation (20%)

請參考以下英文內容，將英文內容翻譯成中文，寫於答案紙上。

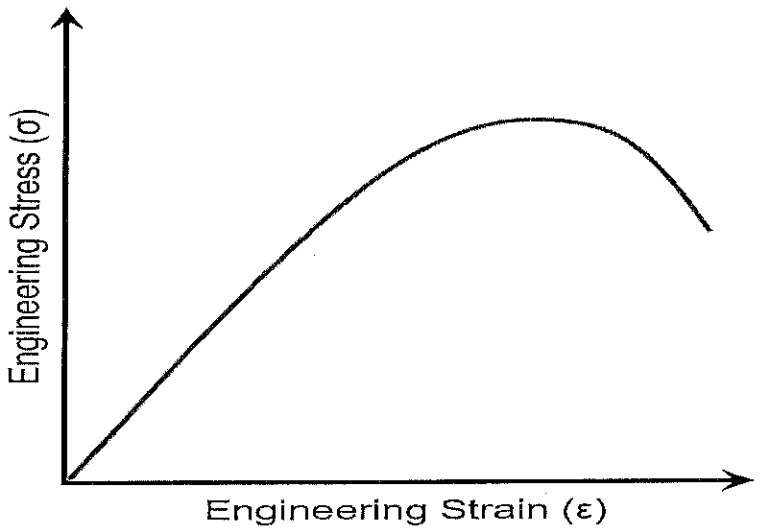
1. Failure of mechanical components are often predictable, in other words, they fail gradually rather than instantaneously. Therefore, close monitoring of its structural integrity is of key importance for safe operation (10%)

2. Optimization of semiconductor manufacturing processes requires continuously changing of processing parameters from a constantly growing database to obtain in-spec final products (10%)

IV 問答題 Short answer question (20%)

回答下列問題，並寫在答案紙上，可以選擇用中文或英文回答。

1. An engineering stress-strain plot is shown below, label the following on the plot: (a) elastic deformation, (b) plastic deformation, (c) yield strength, (d) ultimate strength, and (e) fracture strain (10%)



2. Please provide one example of material properties to each category (10%)

(a) Mechanical properties:

(b) Physical properties:

(c) Chemical properties:

(d) Manufacturing properties:

(e) Appearance:

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：自動控制【機電系碩士班丙組】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
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- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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）　　

1. (20%) For the system given in Fig. 1.
   (a) (10%) Plot the root locus with respect to K (Assume $K>0$).
   (b) (10%) Determine the range of K for stability.

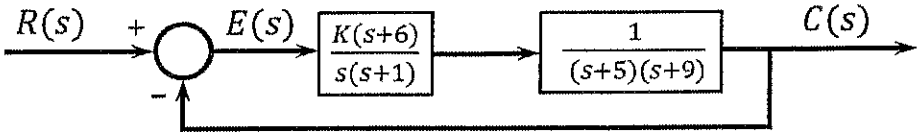

Fig. 1

2. (10%) In Fig. 2, please find the transfer functions, $G_1(s) = X_1(s)/F(s)$ and $G_2(s) = X_2(s)/F(s)$, for the system if M_1=8 kg, M_2=5 kg, B_1=4 N-s/m, B_2=3 N-s/m, K=3 N/m.

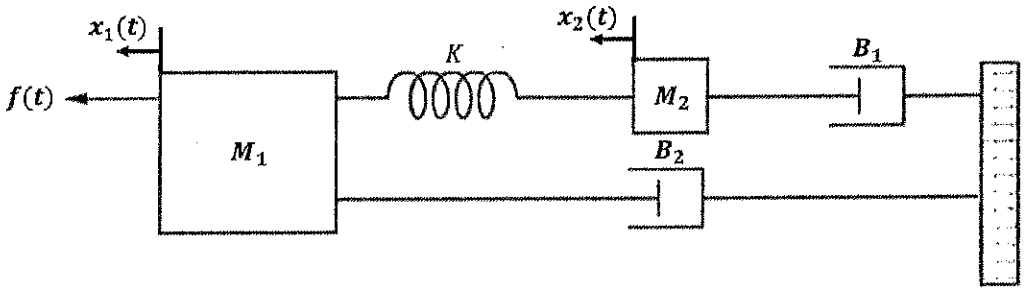

Fig. 2

3. (20%) In Fig. 3, consider the operational-amplifier circuit, where R_1=500 MΩ, R_2=20 MΩ, R_3=1 kΩ, R_4=50 kΩ, C_1=0.01 μF, and C_2=0.1 μF.
   (a) (10%) Please find the transfer function $G(s) = V_o(s)/V_i(s)$.
   (b) (10%) Please find the poles and zeros of $G(s)$.

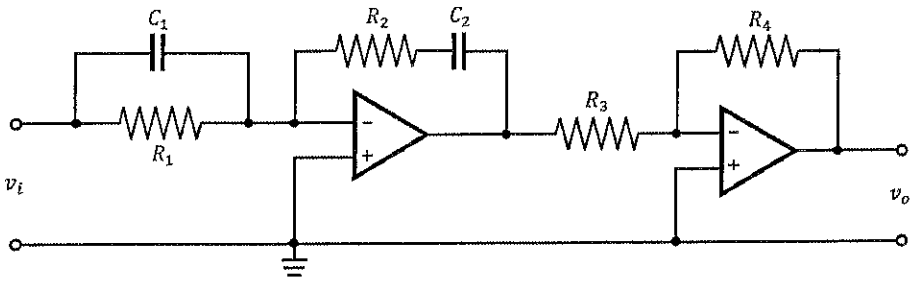

Fig. 3

國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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）　　

4. (50%) 本大題包含10個簡答子題，每個子題請先回答該子題的論述為真或為誤，再以簡明扼要的方式說明理由，記得在回答前要寫上各子題的題號。

A. The fundamental frequency in a Fourier series is the highest frequency component of the signal.
B. Resonance peaks are a desired feature in an ideal frequency response of a control system.
C. The time constant of a first-order system directly determines its bandwidth in the frequency domain.
D. Impulse response analysis is primarily relevant for theoretical calculations and has limited practical use in control systems design.
E. The impulse response of a time-invariant system can be used to predict its behavior under any arbitrary input.
F. The derivative term in a PID controller amplifies high-frequency noise present in the system's feedback signal.
G. Time delay always affects all frequencies in a control system equally.
H. Time delay always results in a reduction in the system's bandwidth.
I. Bode diagrams are only applicable for linear time-invariant (LTI) systems.
J. The frequency response of a system is the Fourier transform of its step response.

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：動力學【機電系碩士班丁組】

－作答注意事項－

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
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- 違規者依本校招生考試試場規則及違規處理辦法處理。

國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

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

1. The velocity of a particle which moves along the x-axis is given by $v = 2 - 4t + 5t^{3/2}$, where t is in seconds and v is in m/s. Evaluate the position x, velocity v, and acceleration a when $t = 3$ s. The particle is at the position $x_0 = 5$ m when $t = 0$ s. (20%)

2. An aircraft A with radar detection equipment is flying horizontally at an altitude of 12 km and is increasing its speed at the rate of 1.2 m/s^2. Its radar locks onto an aircraft B flying in the same direction and in the same vertical plane at an altitude of 18 km. If A has a speed of 1000 km/h at the instant when $\theta = 30°$, determine the values of $\ddot{r}$ and $\ddot{\theta}$ at this same instant if B has a constant speed of 1500 km/h. (20%)

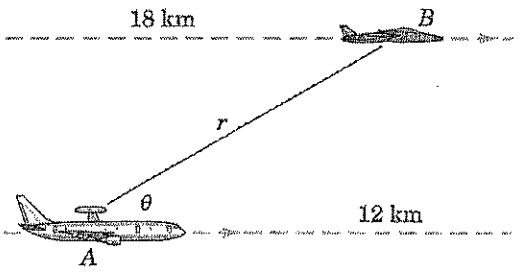

Figure 1.

3. The uniform rod AB of weight $2W$ is released from rest when $\theta = 60°$. Assuming that the friction force between end A and the surface is large enough to prevent sliding. Please determine (a) the angular acceleration of the rod, (b) the normal force at A, and (c) the friction force at A. (20%)

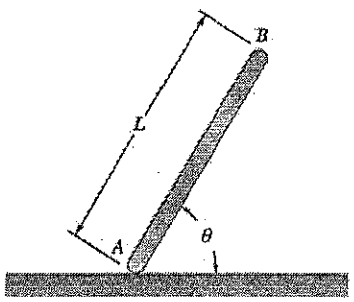

Figure 2.

4. In a game of pool, ball A is moving with the velocity $\mathbf{V}_0 = V_0\mathbf{i}$ when it strikes balls B and C, which are at rest side by side. Assuming frictionless surfaces and perfectly elastic impact, determine the final velocity of each ball, assuming that the path of A is (a) perfectly centered and that A strikes B and C simultaneously, (b) not perfectly centered and that A strikes B slightly before it strikes C. (20%)

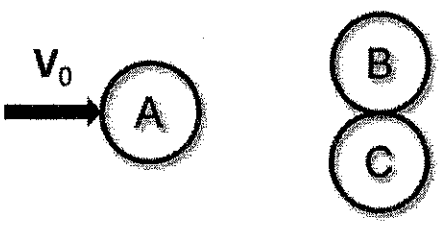

Figure 3.

5. An uniformly loaded square crate is released from rest with its corner D directly above A; it rotates about A until its corner B strikes the floor, and then rotates about B. The floor is sufficiently rough to prevent slipping and the impact at B is perfectly plastic. Denoting by w_0 the angular velocity of the crate immediately before B strikes the floor, determine (a) the angular velocity of the crate immediately after B strikes the floor, (b) the fraction of the kinetic energy of the crate lost during the impact, (c) the angle θ through which the crate will rotate after B strikes the floor. (20%)

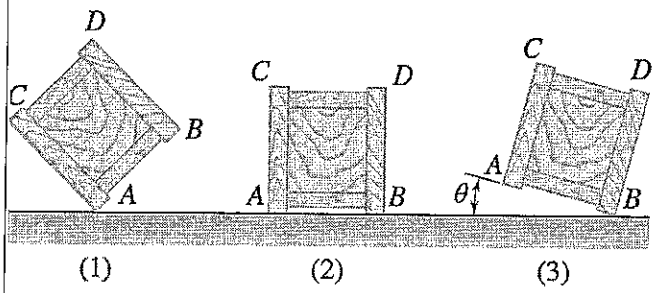

Figure 4.

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：材料力學【機電系碩士班乙組】

一作答注意事項一

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
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- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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）　　

1. (20%) Explain the following terminologies.

   (1) Idealized elastoplastic material

   (2) Engineering stress and true stress

   (3) Statically indeterminate beams

   (4) Tresca and von-Mises yield criteria

   (5) Pin-ended column

2. (20%) Rod ABC consists of two cylindrical portions AB and BC as shown in Fig. P2; it is made of a mild steel that is assumed to be ideally elastoplastic with E= 200 GPa and σ_Y =250 MPa. A force P is applied to the rod and then removed to give it a permanent set δ_p=2 mm. Determine the maximum value of the force P and the maximum amount δ_m by which the rod should be stretched to give it the desired permanent set.

3. (20%) A copper strip (Ec = 105 GPa) and an aluminum strip (Ea = 75 GPa) are bonded together to form the composite beam shown in Fig. P3. Knowing that the beam is bent about a horizontal axis by a couple of moment M = 35 N·m, determine the maximum stress in (a) the aluminum strip, (b) the copper strip.

4. (20%) A spherical pressure vessel has an outer diameter of 3 m and a wall thickness of 12 mm. Knowing that for the steel used σ_{all} = 80 MPa, E = 200 GPa, and ν = 0.29, determine (a) the allowable gage pressure, (b) the corresponding increase in the diameter of the vessel.

5. (20%) The state of stress shown in Fig. P5 occurs in a machine component made of a brass for which σ_{Yield} =160 MPa. Using the maximum-distortion-energy criterion, determine whether yield occurs when (*a*) σ_z=+45 MPa, (*b*) σ_z= - 45 MPa.

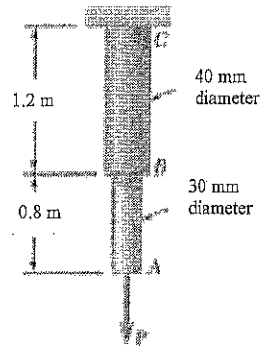

Fig. P2

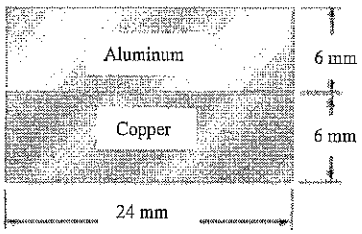

Fig. P3

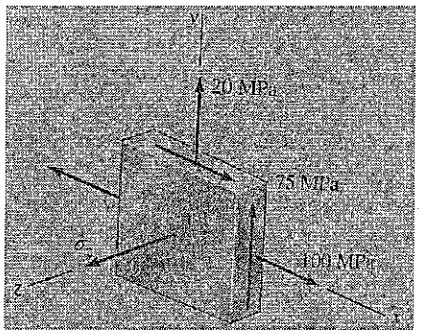

Fig. P5

試題請隨卷繳回，請留意背面是否有題

國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：應用力學(含靜力學及動力學)【機電系碩士班乙組】

－作答注意事項－

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

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）　　

All figures are for illustrative purposes only and not to scale.

1. **(20%)** The object shown in **Figure 1** contains three subblocks; **determine the coordinates of the object's centroid.** The object is homogenous. The unit of length is millimeter, round to the second decimal place.

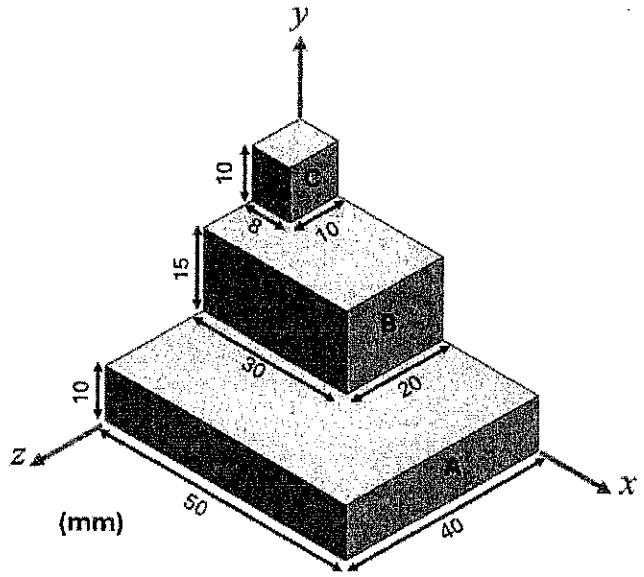

Figure 1

2. **(20%)** A bracket in **Figure 2** is attached with three cables. The cables exert three forces on the bracket. F_1 is on the xy plane, F_2 is on the xz plane, and F_3 is toward the negative z direction. Neglect the thickness of the bracket, **replace the forces with an equivalent force-couple system at point *D***. Use newton (N) and meter (m) for the units of the answers. Use **i**, **j**, **k** for the unit vectors with respect to x, y, z coordinates. (10% for the force and 10% for the couple)

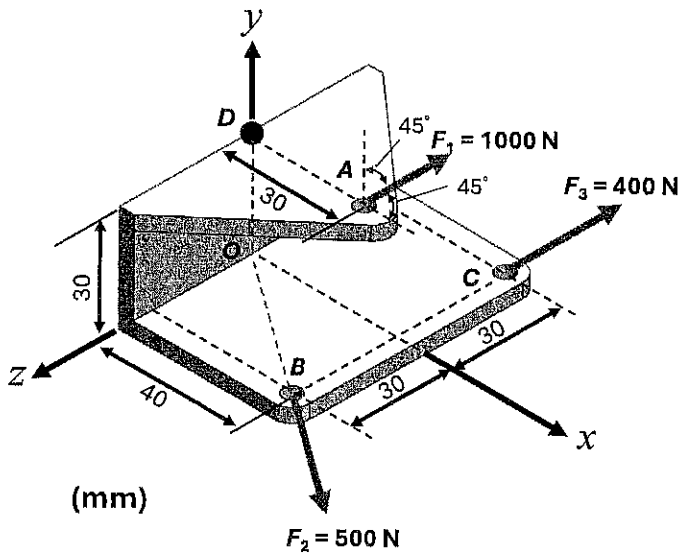

Figure 2

(There are questions on the next page.)

3. **(20%)** As shown in **Figure 3**, in the beginning, block *A* is sliding to the right with a speed of 13 m/s, and ball B is resting at the edge of the step. The distance between block *A* and ball *B* is 10 m. After an *elastic* collision, ball *B* falls to point *B'* as shown in the figure. Block *A* is 5 kg, and ball *B* is 10 kg. Neglect the volumes of the block and the ball, **determine the distance that block A slides after collision**. ($g = 9.8$ m/s^2)

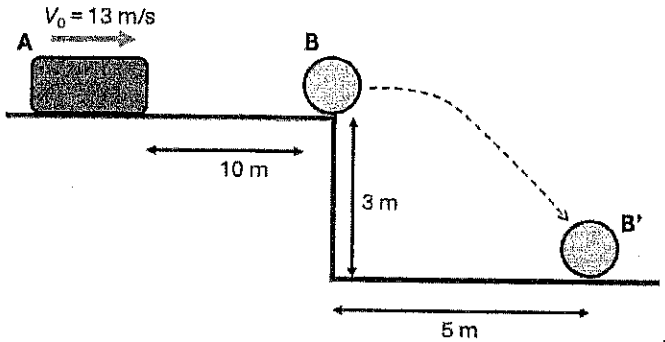

Figure 3

4. **(20%)** An 18-kg slender rod is attached to a spring with an unstretched length of 5 m. In the beginning, when $\theta = 30°$, the rod has an angular velocity of 3 rad/s CW. Determine the angular velocity of the rod when $\theta = 90°$. ($g = 9.8$ m/s^2)

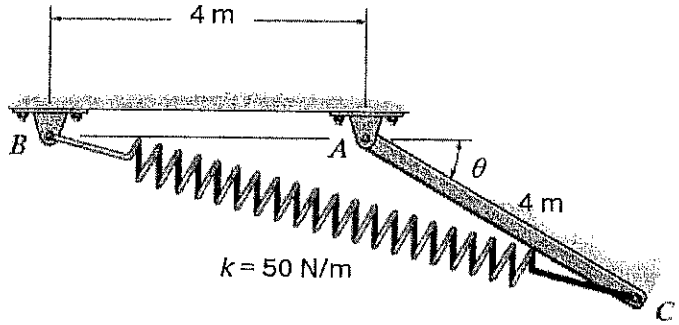

Figure 4

5. **(20%)** The plate gears *A* & *B* in **Figure 5** rotate with the angular velocities as shown. Determine:
(1) (10%) The angular velocity of gear *C* about the shaft *DE*.
(2) (10%) The angular velocity of *DE* about the y-axis.

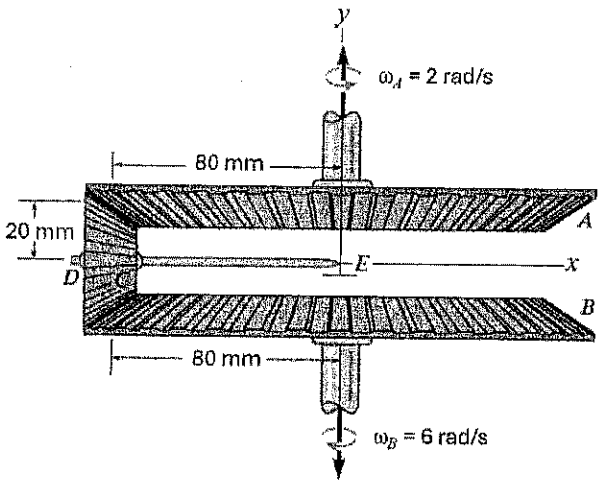

Figure 5