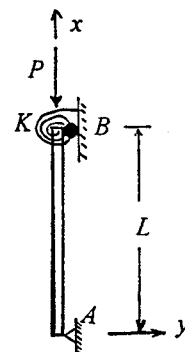# 94 學年度國立成功大學土木工程系結構組博士班入學考試

材料力學試題

下列八題中請選擇五題作答並標明作答題號，每題 20 分，滿分為 100 分。
如作答題數超過五題，則由得分最低之五題加總計算成績。

1. 如圖所示，考慮長 L、二次面積矩 I、楊氏係數 E 之柱 AB，A 為鉸接端，
   B 端為一滾接支承加一彈性係數為 K 之螺旋彈簧(提示：B 端彎矩 M_B 與轉
   角 θ_B 關係為 $M_B = -K\theta_B$)，承受軸向力 P 作用而挫曲。
   (a)試推導挫曲時之微分控制方程式(採用圖示之座標系統)。
   (b)試求挫曲時臨界載重 $P_{c.r.}$ 必須滿足之代數方程式。
   (c)考慮 $K = 0$ 時之臨界載重 $P_{c.r.} = ?$
   (d)考慮 $K \to \infty$ 時之臨界載重 $P_{c.r.} = ?$
   (提示：代數方程式 $\tan x = x$ 之最小正數近似解為 $x = 4.4934$)

2. 有一長度為 L 的均質梁承受某種未知載重，若已知梁的撓曲變位函數 $y(x)$，其中 x 為梁
   的軸向座標，試問：
   (1) 是否可由 $y(x)$ 來判斷梁的**邊界情況**？若回答是，請說明如何判斷；若回答否，請說明
      原因。
   (2) 是否可由 $y(x)$ 來判斷梁中**其它支承之存在和位置**？若回答是，請說明如何判斷；若回
      答否，請說明原因。
   (3) 是否可由 $y(x)$ 來判斷梁的**載重情況**？若回答是，請說明如何判斷；若回答否，請說明
      原因。
   (4) 是否可由 $y(x)$ 來判斷梁的**損壞情況和位置**？若回答是，請說明如何判斷；若回答否，
      請說明原因。
   註：可為你的答案補加任何「合理」的假設，但需說明之。

3. 一根長線依其本身重量垂直懸掛著，若該線係由具有極限應力 $3kN/mm^2$ 之鋼材所做成。
   若不致斷裂，求其所能勝任之最大長度。(註：鋼的單位重量為 $80\ kN/m^3$)

4. Bars AB and BC both have a constant cross-sectional area $A_1 = A_2 = A$. Both materials have an
   elastic, perfectly-plastic stress-strain behavior as shown below. If the load P is increased
   until $\varepsilon_2 = -1.5\varepsilon_Y$ and is then removed, what residual stresses will be left in the two bars?
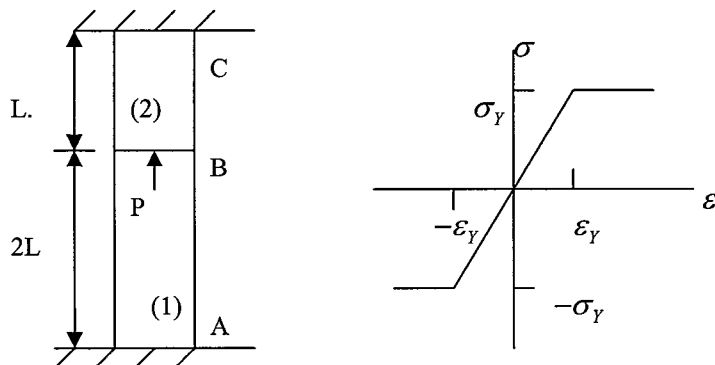
5. Using a 45° strain rosette, the strains $\varepsilon_1 = \varepsilon_{0^\circ}$, $\varepsilon_2 = \varepsilon_{45^\circ}$, and $\varepsilon_3 = \varepsilon_{90^\circ}$ have been determined at a given point. Determine the principal strains.
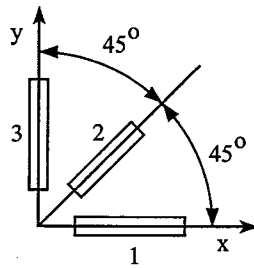
6. A cantilever beam AB having rectangular cross section with constant width b and varying height h_x is subjected to a concentrated load P at the free end. If $h_x = h_0(1 + 6x/5L)$, determine the maximum bending stress.
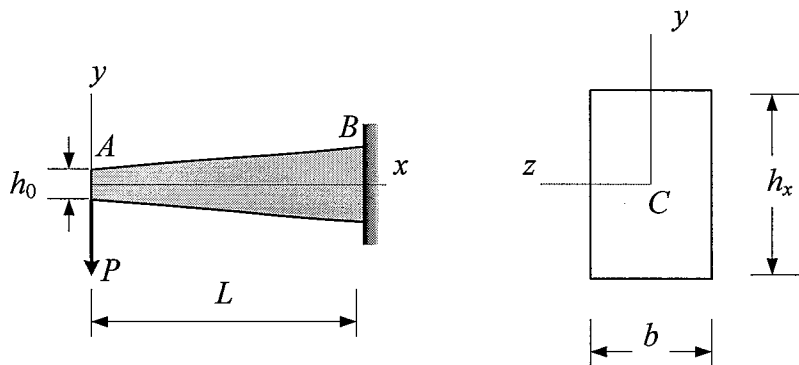
7. (A) Explain: (i) warping function, (ii) torsional rigidity. (B) Considering cylindrical shafts with the same cross-sectional area (but with different shapes), can we identify a certain cross-sectional shape that corresponds to a maximum or a minimum torsional rigidity? and why.

8. An overhanging beam ABC is subjected to loads as shown. The cross section of the beam is also shown below. Calculate the maximum normal stress σ_{max} and the maximum transverse shear stress τ_{max} in the beam.
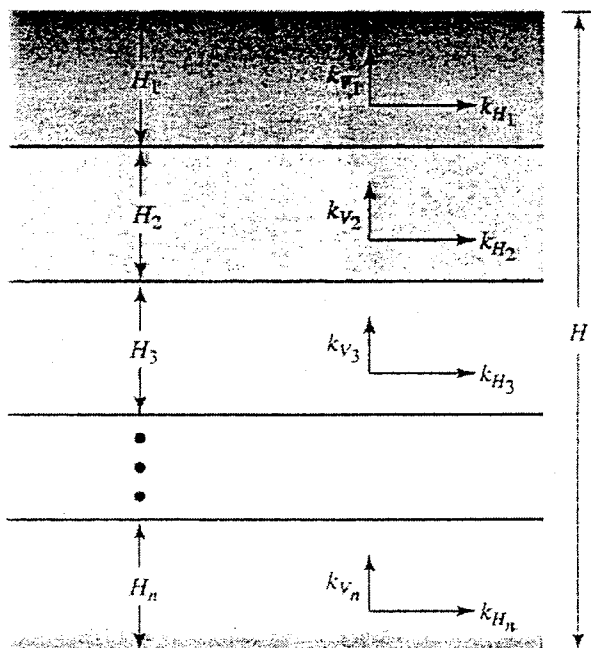

cross section
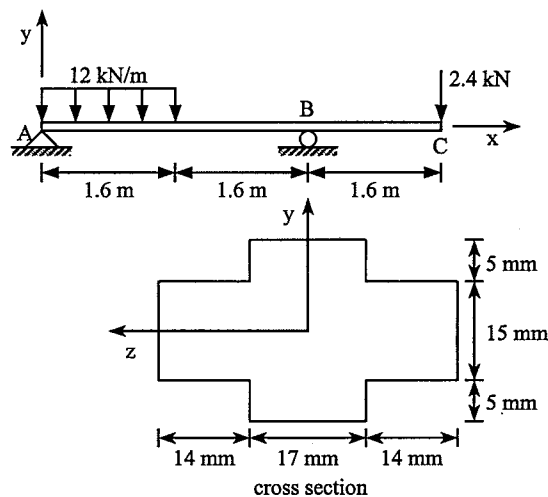
1.在一篩分析試驗得到結果如下表所示，請①繪出粒徑分佈曲線②D_{10}、D_{30}、D_{60} 為何？③均勻係數 C_u、級配係數 C_z 為何？

美國標準篩	篩孔尺寸(mm)	停留於各篩的 土壤質量(g)
4	4.75	0
10	2.00	18.5
20	0.850	53.2
40	0.425	90.5
60	0.250	81.8
100	0.150	92.2
200	0.075	58.5
底盤	—	26.5

2.有一地盤如圖所示厚度為 H，是由 n 層土層所構成，各土層厚度為 H_i (i=1~n)，每層之垂直向及水平向滲透係數分別為 k_{Vi} 及 k_{Hi} (i=1~n)，請問此地盤之垂直向及水平向之總滲透係數 k_V 及 k_H 為何？

3. 標準 **1-D** 壓密試驗其載重增量比 (load-increment ratio)，載重延時(load duration)及試體厚度 (specimen thickness)均有一定規定。試說明以上這些項目若不照標準試驗之規定時，其對試驗結果之影響並說明次要壓密(secondary consolidation)對壓密試驗結果之影響（可繪圖輔助說明）。
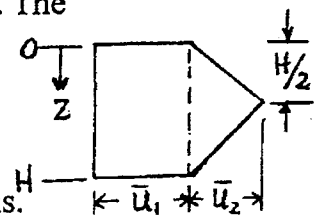
4. 有一 **18m X 16m** 之基礎，其開挖深度為 **3m**，結構物載重 **Q = 30 X 10³ kN** ，土層結構如下圖所示。試求

   (1)基礎承載力之安全係數
   (2)黏土層之壓密沉陷量
   (3)基礎以完全補償式(fully compensated)設計時，其埋入深度
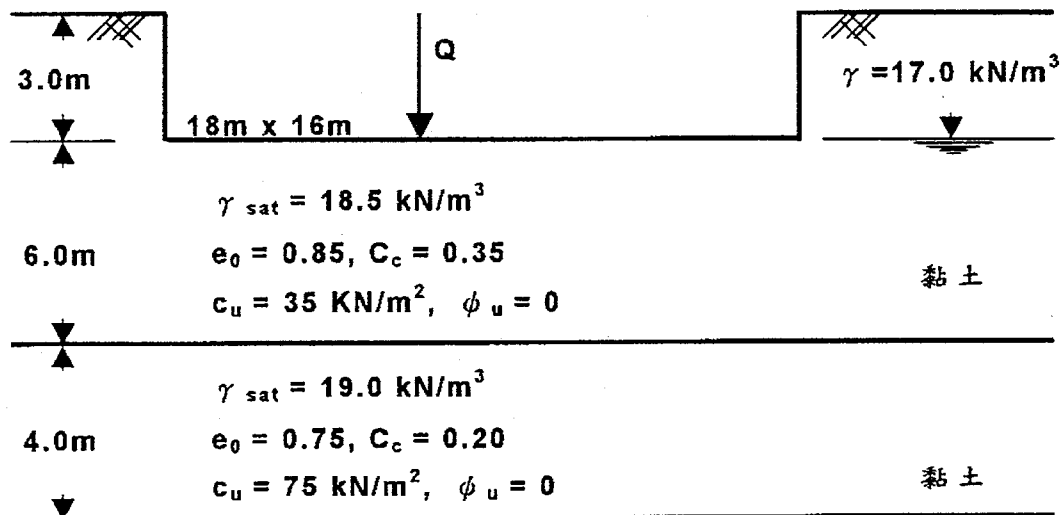
5. The stress surface of a one dimensional consolidation problem is shown to th left. The upper and lower boundaries are impervious. The governing equation is :

$$\bar{u} = (C_1 \cos Az + C_2 \sin Az)e^{\wedge}(-A^2 C_v t)$$

   a. Write down equations for the boundary and initial conditions.
   b. Evaluate the two coefficients for the boundary conditions.
   c. Determine the period.
   d. Set up the equation for the Fourier series coefficients in integral form, do not perform the integration.

6. A direct shear test was performed on a specimen of dry sand using a vertical normal stress of 70 kPa. The value of ϕ for the sand is 32 degrees. Assume that the horizontal plane is the failure plane for the following calculations:
   a. Calculate the horizontal shear stress which would be required to cause failure.
   b. Using the results from part (a) contruct the Mohr's circle for the stresses at failure. Assume that the shear stress on the top of the specimen acts to the left. Show the location of the pole point.
   c. Determine the major and minor principal stresses both graphically from the Mohr circle and analytically (by equations).
   d. Show by means of a sketch the directions of the principal stresses and the directions of the two sets of failure planes.
   e. Determine the horizontal normal stress at failure.

7. 試述上界值理論(Upper bound theory)與下界值理論(Lower bound theory)與其具體求解步驟。

8. 何謂 Cam clay model ？以簡圖說明之。

第一題(40 分)

In 1885, Boussinesq formulated a set of equations to calculate the stress, strains and deflections of a homogeneous, isotropic, linear elastic semi-infinite space under a point load. The equation for vertical displacement for a point load is shown as
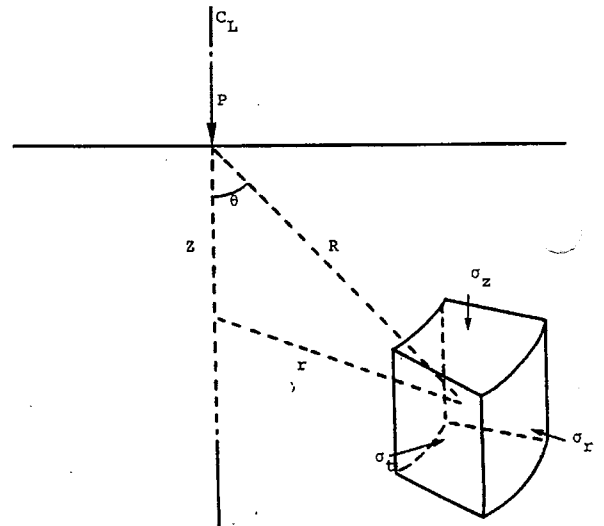
$$\delta = \frac{(1+\mu)P}{2\pi RE}\left[2(1-\mu)+\cos^2\theta\right]$$

Please derive the equation below for vertical displacement for a circular distributed load, σ, with loading radius a)

$$\delta = \frac{(1+\mu)\sigma \cdot a}{E}\left[\frac{1}{\sqrt{1+\left(z/a\right)^2}}+(1-2\mu)\left(\sqrt{1+\left(z/a\right)^2}-z/a\right)\right]$$

Note :

$$\int \frac{x}{\sqrt{x^2+a^2}}dx = \sqrt{x^2+a^2} \qquad \int \frac{x}{\left(x^2+a^2\right)^{3/2}}dx = -\frac{1}{\sqrt{x^2+a^2}}$$

第二題(30 分)

Briefly describe the Superpave asphalt binder testing equipment and purpose.

第三題(30 分)

緩和曲線為公路平面線形設計的重要設計要素之一。試說明其功用何在。

「結構材料」試題

1. 等向性均質之樑，當承受微小之靜態載重時，可以下式

$$\frac{d^4y(x)}{dx^4} = \frac{q(x)}{EI},$$

(20)

來計算其位移 y(x)，其中，q(x) 為單位長度之載重，EI 為此樑之剛度.
但若載重增加到某種程度，則你如何修正上述之有關物理行為及計算式.
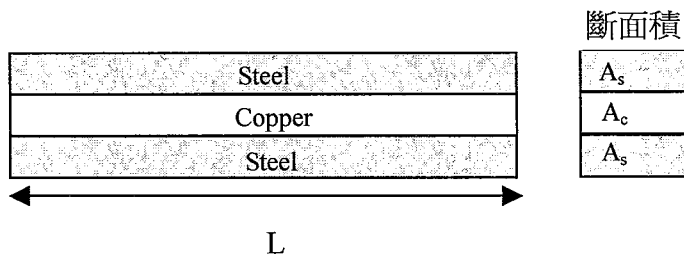
2. 等向性均質之樑，當承受微小之動態載重時，其方程式有幾種？其各自之考量因素為何？

(20)

3.解釋名詞: (15%)

    (a) 非晶質材料(amorphous material)

    (b) 鹼骨材反應(Alkali-aggregate reaction)

    (c) 潛變(creep)

4. 考慮一桿件由鐵和銅結合所組成，其長度為 L，各部分斷面積如圖所示。
已知鐵與銅之楊氏模數分別為 E_s 與 E_c，且熱膨脹係數分別為 α_s 與 α_c。當桿件溫度由 T_o 升高至 T_1 時，鐵和銅仍緊密結合不分離，請問桿件中鐵的應力為何？又銅的應力為何？以及桿件之伸長量? (15%)

	斷面積
Steel	A_s
Copper	A_c
Steel	A_s

L

Problem 5 （15%）

A truss structure in Figure (1) is subjected to Px and Py forces in horizontal and vertical directions respectively. Member ae, be, ce and de are of equal length, L, and equal area, A. Please calculate the horizontal displacement, Dx, and vertical displacement, Dy, at point "e" if

a) the material of all the truss members is linearly elastic with a Young's modulus, E.

b) the material of all the truss members is nonlinearly elastic with a stress (σ)-strain (ε) relationship of $\sigma = K\sqrt{\varepsilon}$.
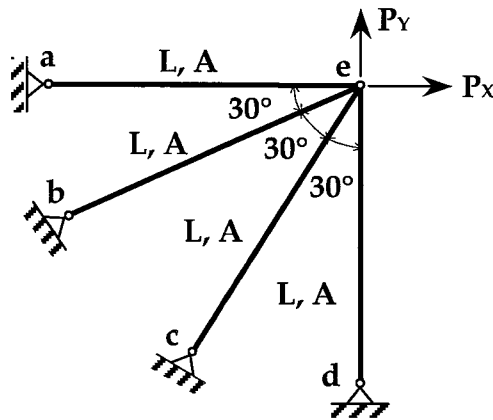

Fig. (1)

(a) $P_x = 2P$

$P_y = P$

(b) $P_x = P_y = P$

$\dfrac{P\sqrt{L}}{KA} = 1$

Problem 6 （15%）

a) What is the meaning of <u>the core of a cross section</u> for beams (or columns) under axial loads?

b) A compressive axial load P acts on a rectangular column of width b and height h as shown in Figure (2). Please derive the equations that enclose the core of the rectangular column section, and neatly draw the core of the cross section on the column section. (note: neglect the buckling effect for this column)
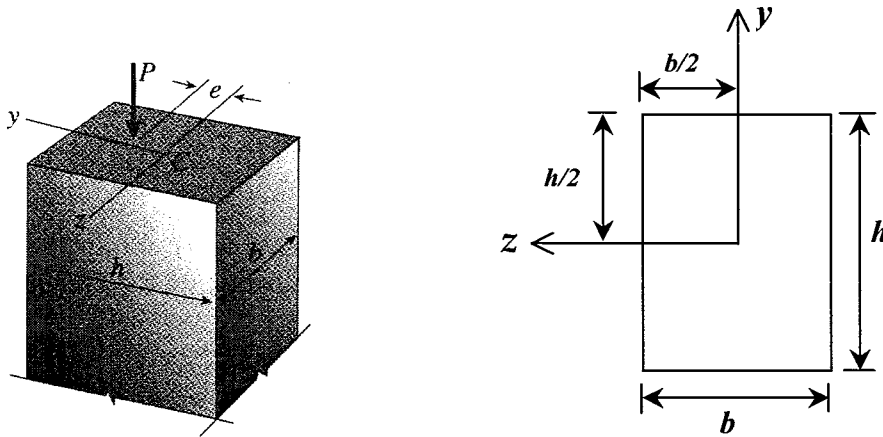
Fig. (2)

成大土木系九十四學年度博士班入學考試工程管理試題

一、解釋名詞：(每題 5 分)

1. Prequalification
2. Constructability
3. Level of Detail
4. Partnering
5. Baseline
6. Construction disputes

二、問答計算題：

1. Please explain the (five or six) steps involved in the construction project planning and scheduling process. (15 分)

2. 某進行中工作包含下列四個作業，請填入下表空格，各作業及整體的表現如何？(15 分)

Activity	Complete (%)	Budget	BCWS	BCWP	ACWP	SPI	CPI
1. Design	100	131	131		144		
2. Specs		146	132	70			0.8
3. Test	15	100			20	0.5	
4. Release	0	55	0		0	-----	-----
Total							

3. The Contractor shall give notice to the Engineer whenever the Works are likely to be delayed or disrupted if any necessary drawing or instruction is not issued to the Contractor within a particular time, which shall be reasonable. The notice shall include details of the necessary drawing or instruction, details of why and by when it should be issued, and details of the nature and amount of the delay or disruption likely to be suffered if it is late. 請說明此段的背景與意義 (20 分)

4. 某工程作業資料如下，假設作業不可分裂，請畫出網圖，計算最早與最晚時間、總浮時，找出要徑。(20 分)

作業	工期	後續作業	關係延時
A	10	B	SS3
		C	FF2
B	8	D	SF4,1
		E	FF5
C	20	G	SS10
D	6	F	FS0
		G	FS4
E	12	F	SS2, FF5
F	14	G	SS3
G	2		