國立交通大學 107 學年度第 2 學期
博士班資格考筆試考試試題

土木工程學系 結構組(甲)　科目：電腦應用於土木工程　選考學生數：1　考試時間：90min

注意：請選其中三題作答！

1. What are the major roles of the computer in design process?

2. 最佳化問題常定義為
   min $E(\mathbf{X})$
   s.t. $g_i(\mathbf{X}) \leqq 0 \quad i = 1, 2, \ldots, n$
   $h_j(\mathbf{X}) = 0 \quad j = n+1, n+2, \ldots, m$
   $\mathbf{X}_l \leqq \mathbf{X} \leqq \mathbf{X}_u$
   除了傳統數學最佳化(gradient-based algorithms)，近來亦有非常多仿生演算法，如基因演算法(genetic algorithm)、粒子群演算法(particle swarm algorithm)、蟻群演算法(ant colony)等。
   (1)試說明傳統數學最佳化演算法之優缺點?
   (2)舉一種仿生演算法說明其解題機制、原理與優缺點。

3. Consider the following problem
   $$\min \quad f(x_1, x_2, x_3) = 2x_1^2 + x_2^2 + 5x_3^2 + 2x_1x_2 + 4x_2x_3 + 6x_1x_3 - 80$$
   Please apply **two iteration** of the conjugate gradient method starting design at (1,2,3) .
   (***hint: new conjugate direction*** $\mathbf{d}^{(k)} = -\mathbf{g}^{(k)} + \beta_k \mathbf{d}^{(k-1)}$ ***and*** $\beta_k = \left(\frac{\|\mathbf{g}^{(k)}\|}{\|\mathbf{g}^{(k-1)}\|} \right)^2$.
   $\mathbf{d}^{(0)} = -\mathbf{g}^{(0)} = -\nabla f(\mathbf{x}^{(0)})$)

4. In artificial neural networks (ANN) domains, error back-propagation (BP) is one of important learning models.
   (a) Please present the flowchart of error back-propagation (BP) learning algorithm.
   (b) What is the main function for momentum term in conventional BP algorithm?
   (c) Can we normalize the outputs in the interval of [0, 1] as the sigmoid function $1/(1+e^{-x})$ is utilized? Why?
   (d) Please derive the $\Delta w_{kj} = -\mu \frac{\partial E(W)}{\partial w_{kj}}$ for weights between output layer and hidden layer.
   Here, system error is defined as
   $$E = \frac{1}{2P} \sum_{p=1}^{P} (d_p - o_p)^2$$
   where P is number of training instances. d_p and o_p are the desired and computed output for the pth training instance.

5. Please use "4R" diagram or relations to describe case-based reasoning (CBR) model and also compare with CBR with other AI system (e.g. production system) for advantages vs. disadvantages.

6. Given the following fuzzy rules:

R1: If (E1=*very high*) and (E=*low*) Then (*H*1)

R2: If (E2=*low*) and (E=*high*) Then (*H*2)

R3: If (E2=*a little low*) Then *H*3

R4: If (E3=very *high*) Then *H*3

Assume that the membership value for membership function is defined as

high	$\mu_{high}(x) = S(x:0,\ 0.5,\ 1.0)$
low	$\mu_{low}(x) = \sim \mu_{high}(x)$
very high	$\mu_{very\ \ high}(x) = \mu_{high}(x)^2$
a little low	$\mu_{a\ \ little\ \ low}(x) = \mu_{low}(x)^{0.5}$
somewhat	$\begin{cases} \mu(x) = S(x:0,\ 0.25,\ 0.5) & x < 0.5 \\ \mu(x) = 1 - S(x:0.5,\ 0.75,\ 1.0) & x \geq 0.5 \end{cases}$

By given

E1=*very high*

E2=*somewhat*

E3=*low*

E=*very high*

please calculate the results of *H*1, *H*2 and *H*3.

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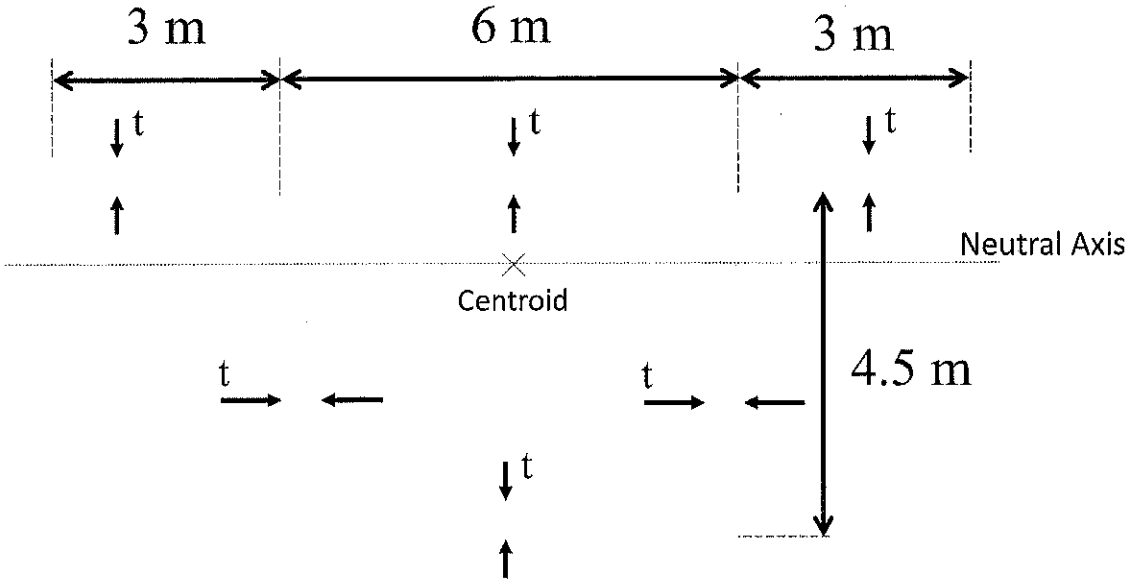
土木工程學系 結構組(甲)　　科目：**高等材料力學**　　選考學生數：1　　考試時間：90min

1. (50%) A box girder bridge is being designed. The cross section of the girder is shown in the figure.

   (a) (20%) Find the second moment of area $I_{c\text{-}c}$ of the box girder cross-section about the neutral axis. Assume t = 0.2m, where t is the wall thickness of the box girder. (*hints: locate the centroid first and apply parallel axis theorem to determine* $I_{c\text{-}c}$)

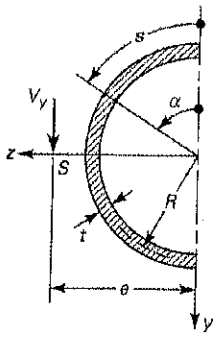
   (b) (20%) If the allowable compressive bending stress for the section is $\sigma_{c,allow}$ **= −250 MPa** and the allowable tensile bending stress is $\sigma_{t,allow}$ **= 400 MPa** respectively, what are maximum sagging (positive) and hogging (negative) moments can be resisted by the girder?

   (c) (10%) Suppose the allowable shear stress is τ_{allow} **= 150 MPa**. Determine the maximum shear resistance of the girder.



2. (25%) A steel shaft of radius $r=75\text{mm}$ is subjected to an axial compression force $P=81\text{kN}$, a twisting couple $T=15.6\text{kN}\cdot\text{m}$, and a bending moment $M=13\text{kN}\cdot\text{m}$ at both ends. Calculate the principal stresses, maximum shear stress, and the planes on which they act in the shaft.

3. (25%) A beam is constructed of half a hollow tube of mean radius R and wall thickness t as shown in the below figure. Assume $t \ll R$, locate the shear center S. The moment of inertia of the section about the z axis is $I_z = \dfrac{\pi R^3 t}{2}$.



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土木工程學系 結構組(甲)　　科目：**有限元素法**　　選考學生數：1　　考試時間：90min

1. (100%) Use Galerkin's method to formulate a *quadratic* finite element for solving the following differential equation:

$$\frac{d^2u}{dx^2}+u=2\sin x,\quad 0\le x\le 1$$

$$u(0)=u(1)=0$$

(a) (30%) Apply weighted integral and integration by parts to obtain an integral form by using $u(x)=\sum_{i=1}^{3}N_i(x)u_i$. Express the equations in terms of N_i.

(b) (40%) Obtain the element stiffness matrix $\mathbf{k}^{(e)}$ by using element nodal coordinates $x_i\,(i=1\sim 3)$.

(c) (30%) Obtain the solutions by using two elements.

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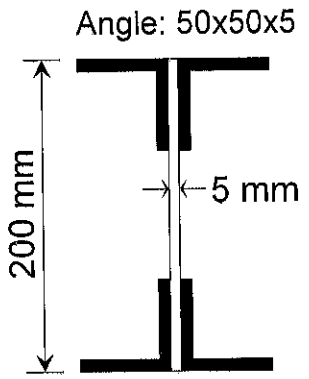
土木工程學系 結構組(甲)　　科目：高等鋼結構　　選考學生數：1　　考試時間: 90min

1. 請針對鋼結構特殊彎矩構架(Special Moment Frame, SMF)系統，回答下列問題：
(a) 請說明其耐震原理及設計考量。(15%)
(b) 請說明其常見之破壞模式。(15%)
(c) 請列出三種改良型式梁柱接頭，並說明其設計原理(15%)

2. 請針對偏心斜撐構架（Eccentrically Braced Frame, EBF）系統，回答下列問題：
(a) 請說明其連桿分類及相對應的行為特性。(15%)
(b) 請列出三種 EBF 連桿的配置方式，並推導連桿轉角與構架層間位移角的關係。(15%)

3. 請計算圖 1 組合斷面的降伏彎矩 M_y 及塑性彎矩 M_P。(25%)



Material:
A992 Steel for Angles.
A36 Steel for web plate.

圖 1