九十九學年度第一學期土研所博士班資格考試(99.10)

有限元素法　　　　Finite Element Method

(1) Consider a two-section bar as shown in Fig. 1, in which the left hand side of the bar is clamped, and the right hand side is subjected to a concentrate load P. The strong form of this problem is given as follows:

GE: $$\frac{d}{dx}\left(AE\frac{du(x)}{dx}\right)=0,$$

BCs: $$u(x=0)=0,$$

$$\left[AE\frac{du}{dx}\right]\bigg|_{x=2L}=P.$$

(a) Find the exact solution. (10%)

(b) Determine the finite element solutions using two linear elements with uniform spacing. (10%)

(c) Compare the results of displacement and axial force obtained by the analytical and FEM approaches. (10%)

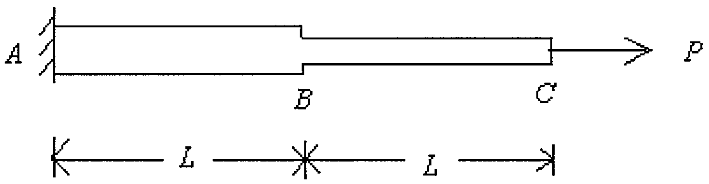


Fig. 1

(2) Derive the equations for the beam element on an elastic foundation, which are $\sum_{j=1}^{4} K_{ij}^{(e)}\Delta_j^{(e)} = F_i^{(e)}$ (i=1~4),

(a) using the principle of minimum potential energy. Here k_f is the subgrade spring constant per unit length. The potential energy of the beam is

$$\Pi_p^{(e)}=\int_0^{L_e}\frac{1}{2}EI\left(\frac{d^2w^{(e)}}{dx^2}\right)^2dx+\int_0^{L_e}\frac{k_f\left(w^{(e)}\right)^2}{2}dx-\int_0^{L_e}q\,w^{(e)}\,dx-Q_1^{(e)}w_1^{(e)}-Q_2^{(e)}\theta_1^{(e)}-Q_3^{(e)}w_2^{(e)}-Q_4^{(e)}\theta_2^{(e)},\quad(15\%)$$

(b) using Galerkin's method. The basic differential equation for the beam on an elastic foundation is

$$\frac{d^2}{dx^2}\left[EI\frac{d^2w^{(e)}}{dx^2}\right]=-q(x)-k_f\,w^{(e)}\qquad\text{in }\ 0<x<L_e\qquad(15\%)$$

where the deflection $w(x)$ in the element domain is expressed as $w^{(e)}(x)=\sum_{j=1}^{4}\phi_j^{(e)}(x)\,\Delta_j^{(e)}$, and the generalized nodal displacements and forces are defined as

$$\left\{\Delta_j^{(e)}\right\}=\left\{w_1^{(e)}\quad\theta_1^{(e)}\quad w_2^{(e)}\quad\theta_2^{(e)}\right\}^T,\quad \theta_1^{(e)}=\frac{dw^{(e)}}{dx}\bigg|_{x=0},\quad \theta_2^{(e)}=\frac{dw^{(e)}}{dx}\bigg|_{x=L_e},$$

$$Q_1^{(e)}=\left[\frac{d}{dx}\left(EI\frac{d^2w^{(e)}}{dx^2}\right)\right]\bigg|_{x=0}=V(x=0),\quad Q_2^{(e)}=-\left(EI\frac{d^2w^{(e)}}{dx^2}\right)\bigg|_{x=0}=-M(x=0),$$

$$Q_3^{(e)} = -\left[\frac{d}{dx}\left(EI\frac{d^2w^{(e)}}{dx^2}\right)\right]\Bigg|_{x=L_e} = -V(x=L_e),\quad Q_4^{(e)} = -\left(EI\frac{d^2w^{(e)}}{dx^2}\right)\Bigg|_{x=L_e} = -M(x=L_e).$$

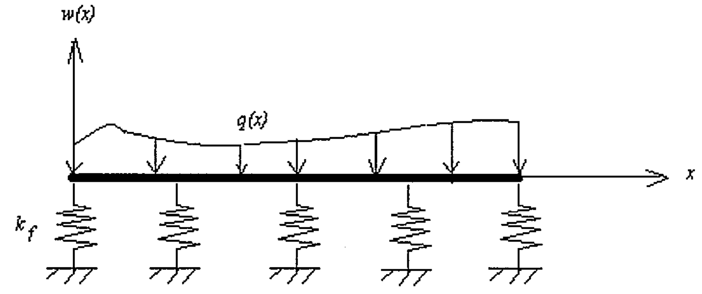


Fig. 2a A beam element on the elastic foundation

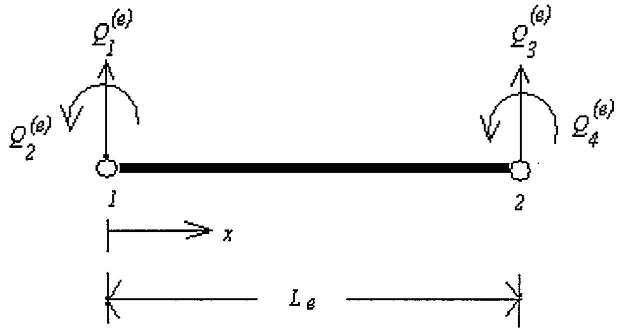


Fig. 2b The nodal variables of a beam element

(3) If the nodal values of the element shown in Fig. 3 are $u_i = \hat{u}_i\ (i=1, 2, 3)$, compute u, $\partial u/\partial x$ and $\partial u/\partial y$ at point $(x, y) = (0.25, 0.25)$. (20%)

Hint: The linear interpolation functions $\phi_i^{(e)}(x, y) = \frac{1}{2A_e}\left(\alpha_i^{(e)} + \beta_i^{(e)} x + \gamma_i^{(e)} y\right)\ (i=1, 2, 3)$ and $\alpha_i^{(e)} = x_j y_k - x_k y_j$, $\beta_i^{(e)} = y_j - y_k$, $\gamma_i = -(x_j - x_k)$, ($i \neq j \neq k$; i, j and k permute in a natural order).

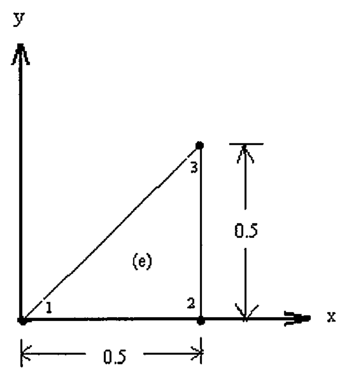


Fig. 3

(4) Give some comments on mesh generation and imposition of boundary conditions. (20%)

九十九學年度第一學期土木所博士學位候選人資格考試
結構動力學

及格分數: 60 分　考試時間: 100 分鐘

1. Please give a brief description of the following questions (you may define qualitatively the required parameters if not given and also give the definition if any terminology is used) (**<u>NOTE: No difficult calculation is required!</u>**) ：(30%)

   (a) What are the acceleration-sensitive region, the velocity-sensitive region, and the displacement-sensitive region on a response spectrum? (make a sketch if necessary)

   (b) For ground motion on firm ground, $T_a = 1/33$ sec, $T_b = 1/8$ sec, $T_e = 10$ sec, and $T_f = 33$ sec, assume any given ζ and

$$R_y = \begin{cases} 1 & T_n < T_n \\ \sqrt{2\mu - 1} & T_b < T_n < T_c \\ \mu & T_n > T_c \end{cases}$$

   How to construct a constant-ductility design spectrum (for $\mu = 2, 4,$ *and* 8) from the elastic design spectrum ? (make a sketch if necessary)

2. Please derive the complete solution for at-rest initial conditions of an undamped single-degree-of-freedom system subjected to a harmonic force. i.e. $m\ddot{u} + ku = P_0 \sin \omega_n t$. Note: $\omega_n = \sqrt{k/m}$. (20%)

3. Please find the max. displacements (u_1 and u_2) of the system (Fig. 3a) under the earthquake design-response-spectrum as shown in Fig. 3b. Solve this problem by using the square-root-of- sum-of-squares rule. (Given $m = 20\,Ton$ and $k = 100\,kN/m$) (50%)

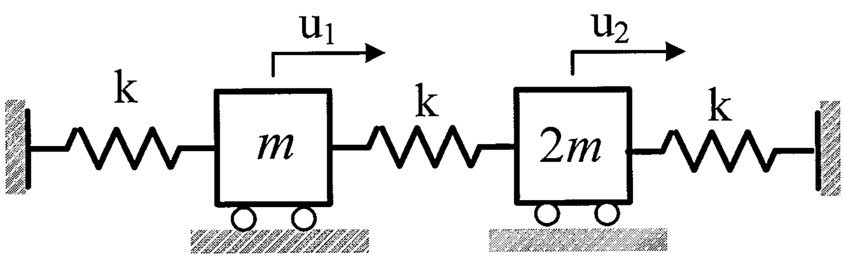


Fig. 3a

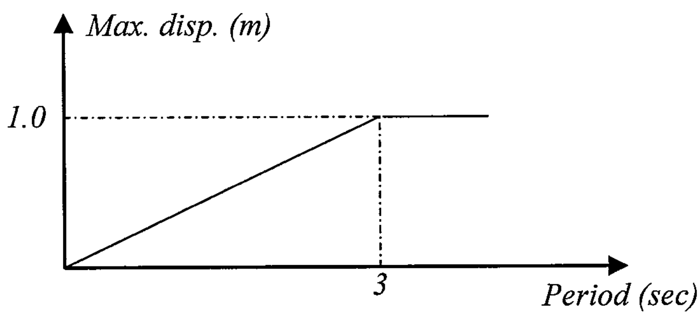


Fig. 3b

99學年度第一學期博士班資格考

一. 將英文翻譯為中文，並申論之(每題20分，共60分)

1. The methods, such as: planar surface method and friction circle method, do not depend on the distribution of the effective normal stresses along the failure surface. However,, if the mobilized strength for a c-ϕ soil is to be calculated, the distribution of the effective normal stresses along the failure surface must be known. The above problem can be solved by discretizing the mass of failure slope into smaller slices and treating each slice as a unique sliding block. For the soil slice system, there are 6n-2 unknowns, while only 4n equations are available. The system is statically indeterminate.
2. In soil mechanics the mathematical solution of stability problem is preceded by the experimental determination of the values of c' and ϕ' and by subsequent replacement of the real soil by an ideal plastic material. This replacement involves the assumption that both c' and ϕ' are independent of strain, i.e., the assumption of a simultaneous failure. Whenever a material is characterized by a stress-strain curve exhibiting a peak, the conditions for simultaneous failure are likely to be violated, because even in a homogeneous material the strains along a potential surface of sliding are not likely to be uniform. This is the so-called progressive failure.
3. The results of mathematical investigations concerning the state of plastic equilibrium beneath continuous footings are not fully satisfactory. Yet the shortcomings are not of serious practical importance because the accuracy of even approximate solutions is limited by our ability to evaluate the appropriate physical properties of the soil that enter into the equations, rather than the defects in the theories themselves. In the approximate methods, it is assumed that the bearing capacity consists in general of the sum of three components computed separately, representing respectively the contributions of :

(1) the cohsion and friction of a weightless material carrying no surcharge.

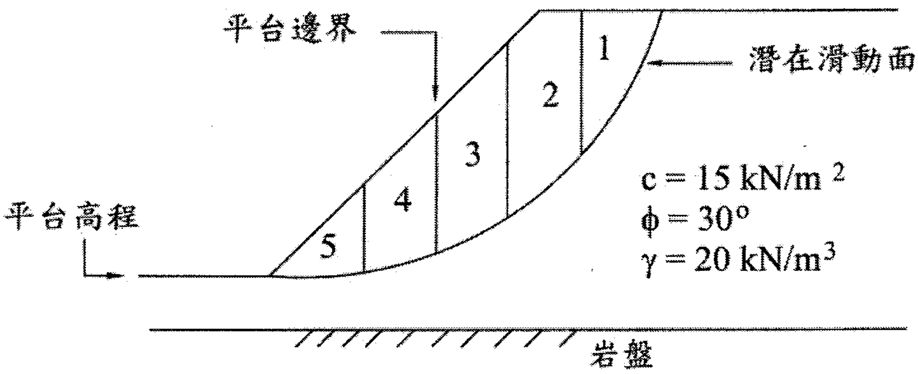
(2) the friction of a weightless material on addition of a surcharge on the ground surface.

(3) the friction of a material possessing weight and carrying no surcharge.

二. 計算題(每題 20 分，共 40 分)

4. 如圖一所示之邊坡及其潛在滑動面資料如表一，於坡腳附近之用地計畫開闢一平台至箭頭所指之邊界處：(1)以表中數據分析，並提出你對此計畫之看法(10 分); (2)可以採用何種工法(列舉 2 種)與上述之用地開闢計畫併用以防止邊坡災害之發生。(描述工法原理、內容和預期效果；10 分)

提示：$F_s = \dfrac{\sum c \cdot \ell_i + (W_i \cdot \cos\alpha_i) \cdot \tan\phi}{\sum W_i \sin\alpha_i}$



圖一

表一

切片編號	切片重 W_i(kN/m)	切片底部仰角α_i(°)	切片寬度 B_i(m)
1	1050	50	6
2	1250	40	6
3	1160	25	6
4	600	10	6
5	500	5	6

5. A smooth vertical wall 4 m high is pushed against an overconsolidated clay (γ = 20 kN/m^3, c′ = 5 kPa, ϕ' = 30°, and average s_u = 150 kPa). The water table in the overconsolidated clay is at the ground surface. The surface of the overconsolidated clay carries a uniform load of 40 kPa. Using the Rankine theory to calculate the resultant pressure per linear meter against the wall when the clay behind the wall fails (1) in an undrained condition (10 分), and (2) in a drained condition (10 分).

九十九學年度第一學期博士學位候選人資格考試

考試科目：工程地質

一. 解釋名詞 (27%)

(1) 何謂礦物的 Curie Temperature(3%)

(2) 試說明礦物的 cleavage?(3%) streak?(3%)

(3) Strike? Dip? Dip direction? (12%)

(4) 說明何謂莫氏不連續面?古氏不連續面?(6%)

二. 試舉出大陸漂移學說的兩個證據? (8%)

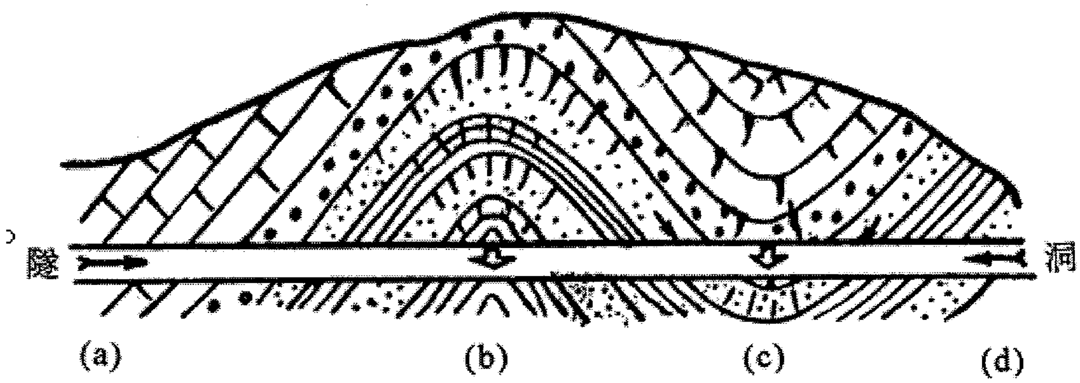
三. 試述 RMR 岩體分類法與 Q 法(14%)

四. 何謂火成岩之整合貫入(4%)與非整合貫入(4%)，並分別寫出一例子(6%)。

五. 試定義(8%)並分別各舉出二種原生弱面與次生弱面(8%)。

六. 試說明何謂邊坡平面滑移破壞、楔型破壞、圓弧破壞、翻覆型破壞(12%)

七. 試問隧道開挖時位於下圖(a)、(b)與(c)點分別可能的工程地質特性為何?(9%)



Mechanical Properties of Materials

材料機械性質

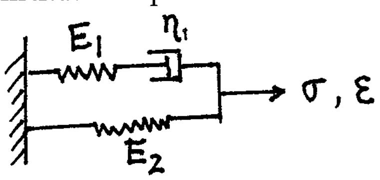
博士資格考

Fall 2010

1. The 9 independent elements of the elastic compliance of an orthotropic material are: $S_{11} = 10^{-10} m^2 / N$, $S_{22}/S_{11} = 13$, $S_{33}/S_{11} = 23$, $S_{12}/S_{11} = -0.4$, $S_{23}/S_{11} = -6$, $S_{31}/S_{11} = -0.5$, $S_{66}/S_{11} = 16$, $S_{44}/S_{11} = 20$, $S_{55}/S_{11} = 16$

   Calculate the strains that result from the following stress state to the orthotropic material: $\sigma_{11} = \sigma_{22} = \sigma_{33} = 13MPa$, $\sigma_{12} = 5MPa$ and $\sigma_{13} = 12\,MPa$. (20%)

2. (a) Derive the constitutive equation for the standard linear solid shown below:



   (b) For the model shown above find the overall $\sigma(t)$ in terms of E_1, E_2 and η_1 when a constant strain ε is applied.

   (c) How will the response change as $t \to \infty$ (24%)

3. (a) Why is the ideal cohesive strength roughly equal to E/10 while the intrinsic lattice resistance is 1.33E/z, where E is the Young's modulus and z is the number of bonded neighbors per atom? (b) Describe the differences between precipitate hardening and dispersion hardening. (c) Why does the yield strength increase with the square root of the inverse of the grain size? (24%)

4. The tensile strength of a brittle material can be described well by the two-parameter Weibull statistical analysis with $m = 6$ and $\sigma_0 = 20MPa$. Calculate the applied concentrated force P loaded at the center of a simply supported beam with a span $L = 10m$ and a rectangular cross-sectional area $10cm x 10cm$ when the failure probability of the beam is 0.5. (20%)

5. Distinguish between high cycle fatigue and low cycle fatigue in terms of phenomenology and the mechanism controlling each type of fatigue. (12%)

鋼鐵材料與結構 2010.10.29

考試方式: **Closed Book**

考試時間: **100 分鐘**

1. (40%) Please give detailed explanations for the following questions:

(a) Please list four chemical elements which can improve the mechanical properties of steel and explain what mechanical property each chemical element can improve.

(b) What are the factors affecting "shear lag effect" in tension member design?

(c) What are the disadvantages of steel as a structural material?

(d) What is "balanced weld" in fillet weld design?

(e) How do we identify "compact section", "non-compact section" and "slender element section" for H-shaped steel sections?

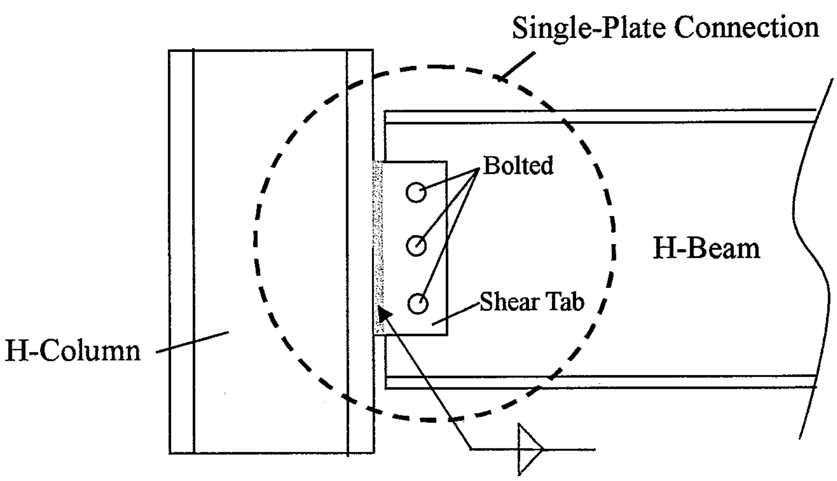
2. (10%) Please discuss the factors that could affect the buckling strength of a real steel column.

3. (15%) In LRFD, limit states of steel structure design are usually categorized into two groups, "strength limit states" and "serviceability limit states".

(a) What are "strength limit state" and "serviceability limit state"?

(b) Please give sufficient examples to "strength limit state" and "serviceability limit state" in steel structure design (at least 3 examples for strength limit states and 2 examples for serviceability limit states).

4. (15%) Please list the limit states needed to be considered for the single-plate connection shown in the following figure.

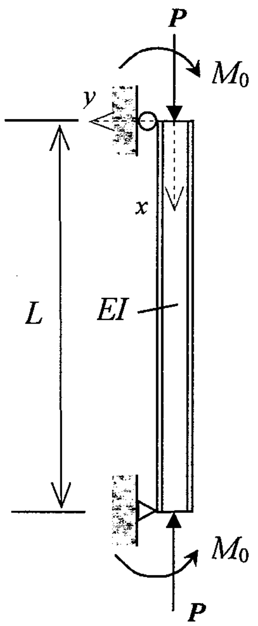


5. (20%) Consider the following simply-supported beam-column with equal end moments (M_0) shown in the following figure.

(1) Please derive the y-direction deflection formula $v(x)$ for this beam-column.

(2) Please derive the moment formula $M(x)$ for this beam-column

(3) Please obtain the theoretical moment magnification factor MAF (or B_1) for this beam-column.



Note: Assume linearly-elastic material

Qualification

1. Use the project data in Table 1 to find the following items: (25%)
   1.1. Draw an precedence diagram network (activity-on-node)
   1.2. ES, EF, LS, LF of each activity
   1.3. TF & FF of each activity
   1.4. Determine project duration
   1.5. Identify critical path and activities

Table 1

Activity Description	Duration (Days)	Predecessors*
I Mobilize	1	
2 Set up scaffolding	2	1
3 Construct security barricades	1	2 SS/1
4 Strip off old roofing	3	2, 3
5 Repair damaged decking	2	4 SS/1
6 Repair damaged cant strip	1	4, 5
7 Replace sheetmetal	1	5, SS/1
8 Install felt roofing	1	6, 7
9 Hot mop roof	2	8
10 Inspect roofing	1	9
II Call for inspection	1	10 SF/3
12 Remove scaffolding	2	10
13 Haul off roofing materials	2	6, 7
14 Demobilize	1	12 FF/1, 13 FF/1

***Under Predecessors. the following notation is used:**

x/#: Activity x must finish # days before this activity can begin.
xSS/#: The # of days after activity x starts that this activity can begin.
xFF/#: This activity cannot finish until # days after x is completed.
xSF/#: This activity must finish # days before x can start.

2. A construction progress is shown as in Figure 1 and Table 2.

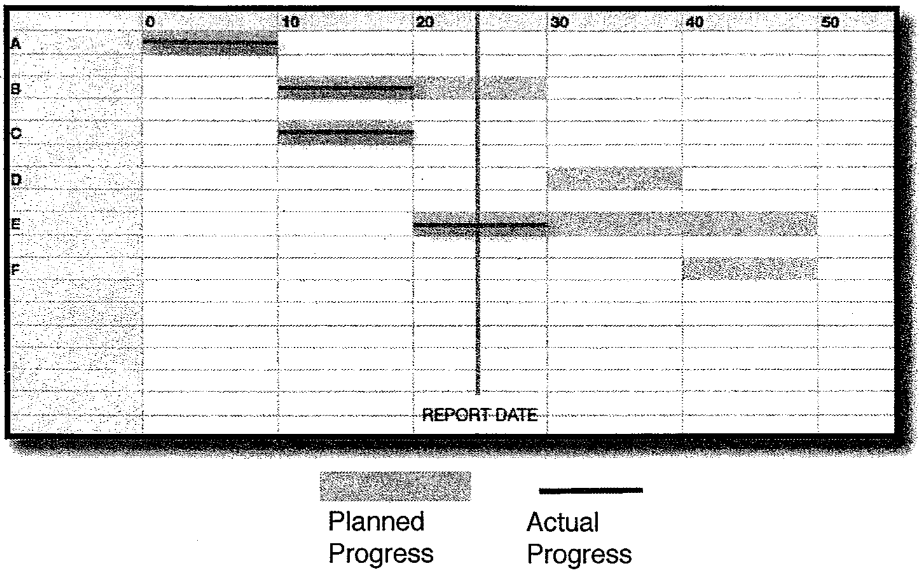


Figure 1

Table 2

Activity	Cost	Scheduled %	Actual %	BCWS	BCWP	ACWP	SPI	CPI	Budget ? Schedule?
A	1000	?	?	?	?	900	?	?	?
B	2100	?	?	?	?	1100	?	?	?
C	3000	?	?	?	?	3100	?	?	?
D	3600	---	---	---	---	--			
E	2000	?	?	?	?	750	?	?	?
F	8000	---	---	---	---	--			
Total	19700			?	?	?			
Project	SPI	?							
Project	CPI	?							
Cost at Completion		?							

2.1. Please fill out the Table 2 to show the project status information of the activities and the construction project. (15%)
2.2. Explain how this construction performs (5%)
2.3. Estimate the cost at completion of this construction project. (5%)

3. You, as the project planner, are planning a residential community project consisting of 10 houses. The required activities for completing each house are listed in Table 3.
   *** All activities should be performed continuously once they are started.**
   3.1. Develop a linear schedule for this project and determine the project duration(10%)
   3.2. You are going to add an extra crew for each activity to reduce the project duration. Which approach would you take to minimize the project duration ? (1) assign an extra crew to the same house, the duration of each activity is cut in half. (2) assign an extra crew to work at different house, the duration of each activity is unchanged. (15%) ***You need to show the linear schedules of the both approaches and explain your reasoning.**

Table 3

Activity ID	Duration	Predecessors
A	4	--
B	2	A
C	6	A
D	8	B, C
E	2	C
F	4	D, E

4. Please solve the network in Figure 1 by the Brooks method (25%)

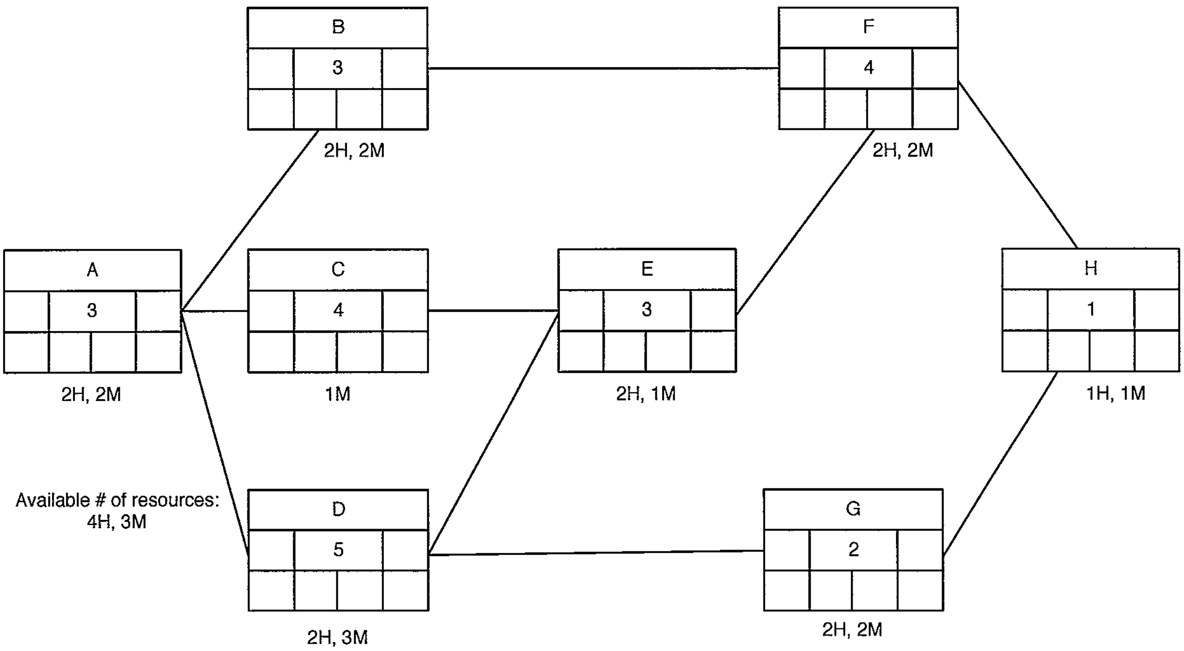


Figure 2