1. (20%) Solve the following differential equations:

   (a) $\frac{dy}{dx} + ky = r(x),\ y(x_0) = y_0.$ (k constant)

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

2. (20%) Solve the following system of differential equations

$$\frac{d}{dt}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 0 \\ \sin t \end{bmatrix}, \quad \begin{bmatrix} x(0) \\ y(0) \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

3. (20%) Solve the one-dimensional wave equation

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2} \quad \text{for } 0 < x < l, t > 0$$

   which satisfies the boundary conditions $u(0,t) = 0,\ u(l,t) = 0$, and the initial conditions $u(x,0) = f(x),\ \frac{\partial u(x,0)}{\partial t} = 0.$

4. (20%) Derive the Euler equations and the associated natural and essential boundary conditions of the functional

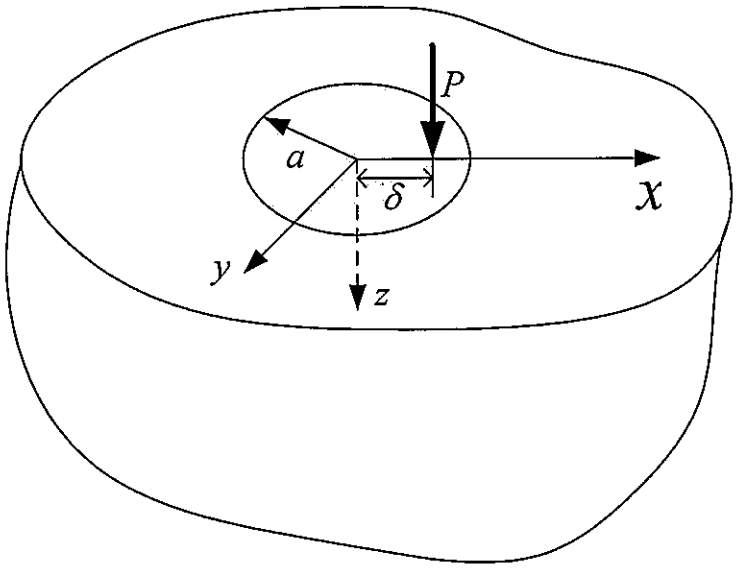
$$I(u) = \int_a^b \left\{ \frac{EI}{2}\left(\frac{d^2w}{dx^2}\right)^2 + qw \right\} dx$$

5. (20%) show that the Cauchy principal value

$$P\int_{-\infty}^{\infty} \frac{e^{itx}}{x}\,dx = \begin{cases} \pi i & (t > 0), \\ 0 & (t = 0), \\ -\pi i & (t < 0). \end{cases}$$

Qualifying examination (Elasticity)

(1) A rigid disk is welded to an elastic isotropic half-space. A load, P, is applied to the disk as shown. Considering the most general motion of the disk, state the boundary value problem. (Don't solve the problem. Statement must include equilibrium requirements). (25%)



(2) For an isotropic linearly elastic medium, the stress-strain relation may be represented as $\sigma_{ij} = \lambda \varepsilon_{kk} \delta_{ij} + 2\mu \varepsilon_{ij}$ where λ, μ are Lame constants.

(a) Show that the equilibrium equations for an isotropic linearly elastic medium are expressible in the form

$$(\lambda + \mu) u_{j,ji} + \mu u_{i,jj} = 0$$

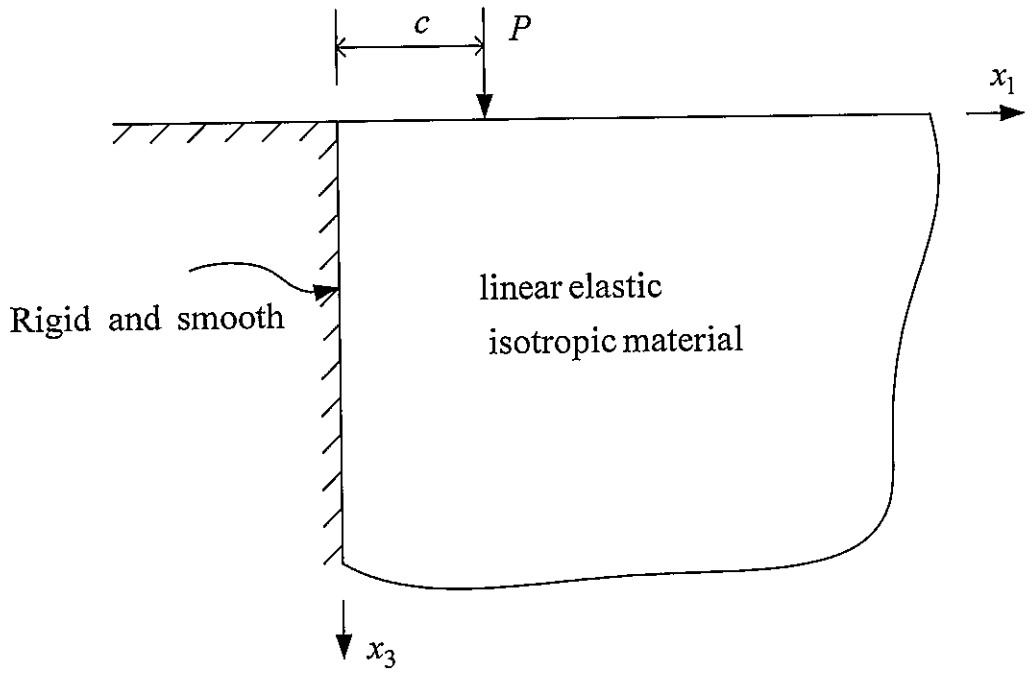
in the absence of body force.

(b)Show that the governing equations in (a) are satisfied identically if $\boldsymbol{u}$ is assumed in the following form

$$u_i = \psi_i + \alpha(\phi + x_j \psi_j)_{,i}$$

where the functions ϕ, ψ_i are harmonic and α is a constant. What is the value for α ? (25%)

(3) A concentrated load P acts at a distance c from a smooth rigid wall and at the surface of an elastic solid. (a) State the boundary conditions at $x_1 = 0$. (b) Suggest the ways how to determine the pressure exerted on the wall.(25%) (Don't solve the problem.)



(4) (a)Express the compatibility equation for the case of plane strain. (Note that there is only one nontrivial compatibility equation for the case of plane strain)

(b) Express the compatibility equation for the case of anti-plane strain.(25%)

100 學年度第 1 學期土木所博士學位候選人資格考試
結構動力學

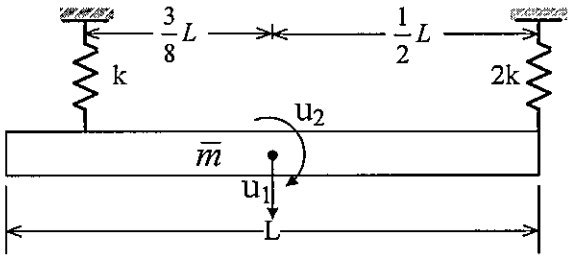
及格分數: 60 分　考試時間: 100 分鐘

1. Please give a brief description of the following questions (**NOTE: No difficult calculation is required!**) ：(30%)

   (a) What are the procedures to construct the combined D-V-A response spectra of a given ground motion? Please make a sketch and also give brief descriptions regarding the acceleration-sensitive region, the velocity-sensitive region, and the displacement-sensitive region. (15%)

   (b) What is the important distinction between earthquake elastic design spectrum and inelastic design spectrum? (15%)

2. Determine the natural frequencies and mode shapes for the uniform, rigid bar ($EI = \infty$) with mass $\overline{m}$ per unit length.
   (Define: u_1: translation, u_2: rotation of the mass center of the rigid bar) (30 %)



3. Please find the max. displacements of 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. (40%)

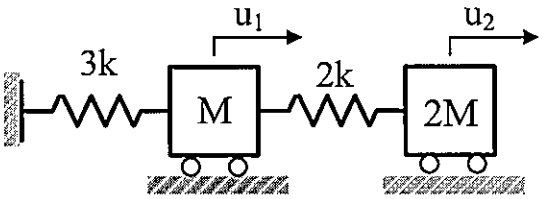


Fig. 3a (Given mass $M = 20\,T$, spring constant $k = 100\,kN/m$)

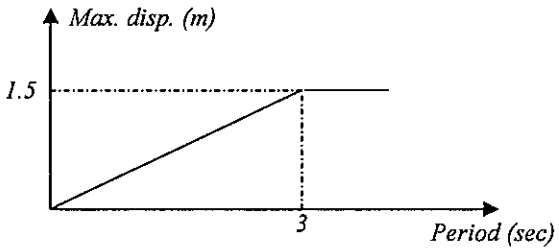


Fig. 3b

100學年度第一學期土研所博士班資格考試 (100.10)
有限元素法（共2頁）

(1) Consider a weightless straight bar element of length L_e, Young's modulus E, and cross-sectional area A, as shown in Fig.1, in which $f(x)$ denotes the distributed horizontal force. The relation between the nodal displacements $\left(u_i^{(e)},\ i=1 \text{ and } 2\right)$ and nodal forces $\left(f_i^{(e)},\ i=1 \text{ and } 2\right)$ for a linear bar element is given as follows:

$$\begin{bmatrix} k_{11}^{(e)} & k_{12}^{(e)} \\ k_{21}^{(e)} & k_{22}^{(e)} \end{bmatrix} \begin{Bmatrix} u_1^{(e)} \\ u_2^{(e)} \end{Bmatrix} = \begin{Bmatrix} \int_0^{L_e} f(x)\phi_1^{(e)}\, d\bar{x} \\ \int_0^{L_e} f(x)\phi_2^{(e)}\, d\bar{x} \end{Bmatrix} + \begin{Bmatrix} f_1^{(e)} \\ f_2^{(e)} \end{Bmatrix}, \tag{1}$$

in which $\left(\phi_i^{(e)},\ i=1 \text{ and } 2\right)$ are the shape functions.

Derive the stiffness matrix and forcing vector of this linear bar element given in Eq. (1) by assuming AE=constant and $f(x)$=constant (i.e., $f(x)=f_0$) and using

(a) the variational method; (10%)

(b) the Galerkin method; (10%)

(c) Will your results of problem (1a) be identical to those of problem (1b)? If yes, state what mathematical property for the differential operator should be satisfied, and describe this property. (10%)

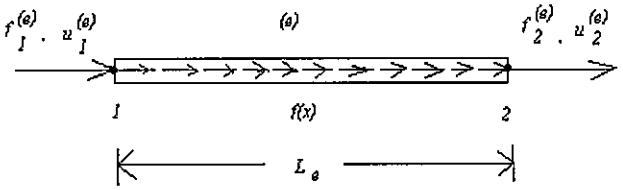


Fig. 1

(2) Consider a uniform bar as shown in Fig. 2, in which the left and right hand sides of the bar are clamped, and the bar is subjected to a uniform distributed horizontal load with magnitude f_0. The strong form of this problem is given as follows:

GE: $\dfrac{d}{dx}\left(AE\dfrac{du(x)}{dx}\right) = -f(x)$ $\qquad 0<x<L,$

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

$u(x=L)=0$,

in which $f(x)=f_0$, and f_0 is a constant.

(a) Determine the exact solution of $u(x)$ using a certain analytical method ? (10%)

(b) Determine the finite element solutions of displacement of point B (u_B) and the reaction forces at points A and C (R_A and R_C) using two linear elements with an equal spacing. (10%)

(c) Compare your two-element solutions of horizontal displacement with the exact ones by drawing the graphics of $u(x)$. (8%)

(d) Compare your two-element solutions of axial force with the exact ones by drawing the graphics of $F(x)$, which is calculated by definition (i.e., $F(x)=AE\dfrac{du^{(e)}}{dx}$). (7%)

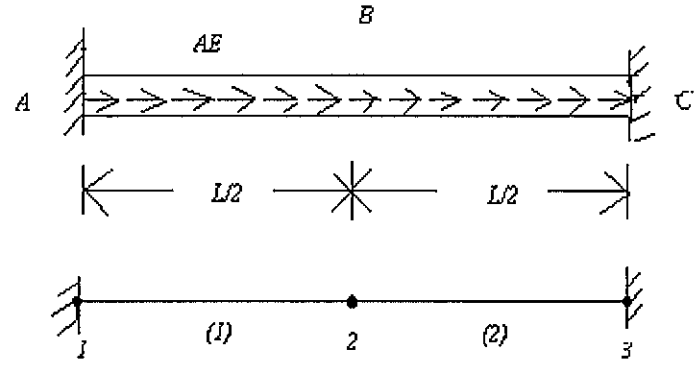


Fig. 2

(3) Two trolleys are connected by the arrangement of springs shown in Fig. 3.

(a) Determine the complete set of equilibrium equations for the system in the form $[\mathbf{K}]\{\mathbf{U}\}=\{\mathbf{F}\}$ using the finite element method with four spring elements, the spring constants of which are given in Fig. 3. (8%)

(b) If $F_B=-F$ and $F_C=F$, compute the displacement of each trolley, the reaction forces at points A and D, and the force in each spring. (7%)

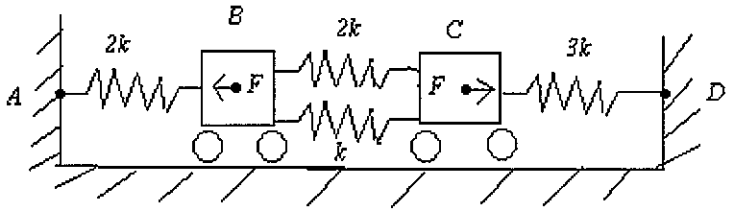


Fig. 3

(4) A thin plate, which is of unit thickness and with a center hole, is supported and loaded as shown in Fig. 4. The material is steel, for which $E=30x10^6$ psi and $\upsilon=0.3$.

(a) Try to arrange two meshes, one is a coarse mesh and the other is a fine one, with combinations of rectangular linear and quadratic elements. (10%)

(b) State how many ways you knew to connect the linear and quadratic elements. (10%)

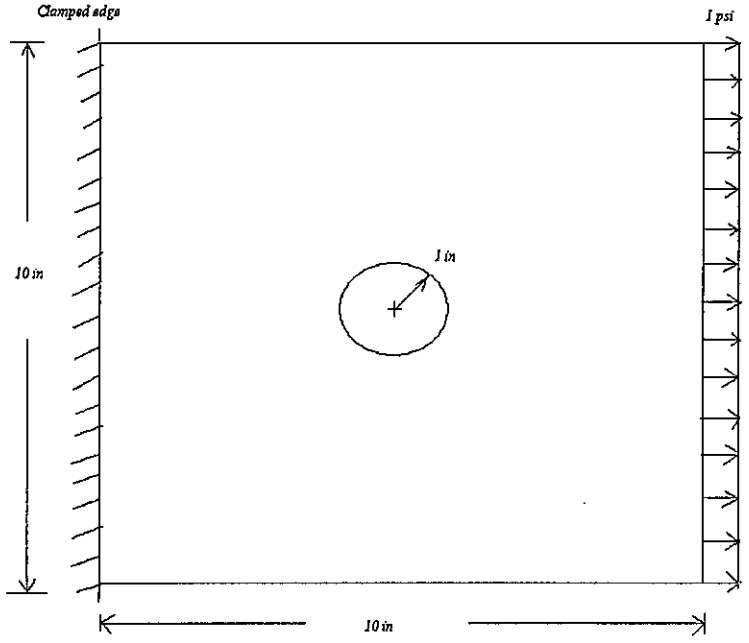


Fig. 4

100 學年度　博士班資格考

Open book test

科目：混凝土材料與結構

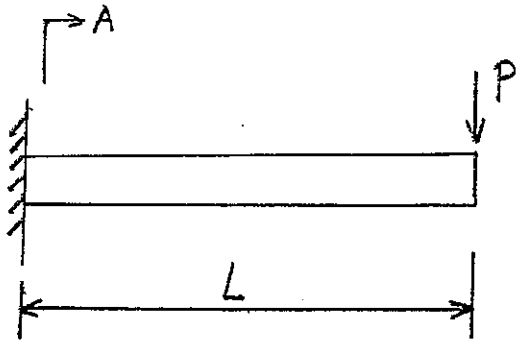
1. (a) Construct the moment-curvature diagram of the beam section (M_{cr}, M_y, and M_u). (20 %)

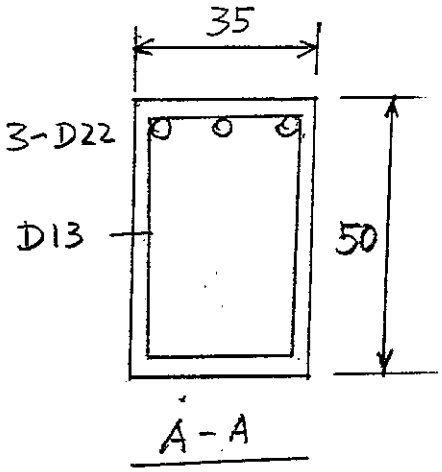
   (b) List the procedure of how to predict the beam tip deflection at flexural cracking, yielding, and ultimate strength stages of the cantilever beam. (10 %)

   Given conditions: $f_c' = 280\ kg/cm^2$, $f_y = 4200\ kg/cm^2$

   D22 bar, $d_b = 2.22\ cm$, $a_s = 3.87\ cm^2$

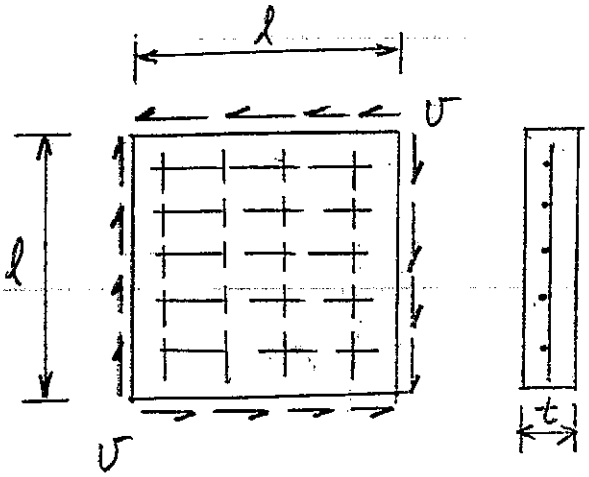
   Unit: cm





2. List the procedure of how to predict the relationship of shear stress and shear strain of the reinforced concrete membrane element.

   Given conditions: steel ratio in longitudinal and transverse direction, respectively: ρ_t, ρ_l; f_c' and f_y. (20 %)



3. List any three characteristics of concrete aggregate and discuss their influence on both the properties of fresh concrete and hardened concrete. (20%)

4. What chemical reactions are generally involved in sulfate attack on concrete? What are the physical manifestations of these reactions? (15%)

5. With the help of the pozzolanic reaction, explain why under given conditions, compared to portland cement, portland pozzolan and portland blast-furnace slag cements are likely to produce concrete with higher ultimate strengths and superior durability to sulfate attack. (15%)

100 學年度第一學期博士學位候選人資格考試

考試科目: 鋼鐵材料與結構

考試方式: Closed Book
考試時間: 100 分鐘

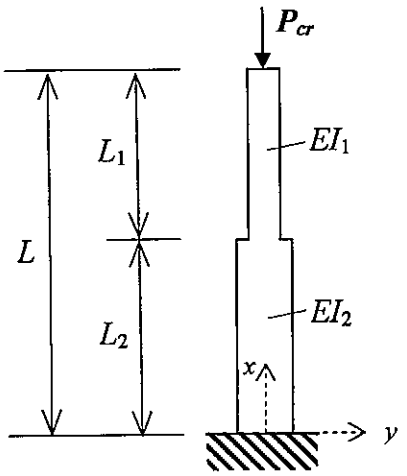
1. (10%) Discuss strengthening mechanisms of steel materials.

2. (20%) Discuss the roles of following chemical components to the mechanical properties of steel.
   (a) Si (silicon)
   (b) P (phosphorous)
   (c) Mn (manganese)
   (d) C (carbon)

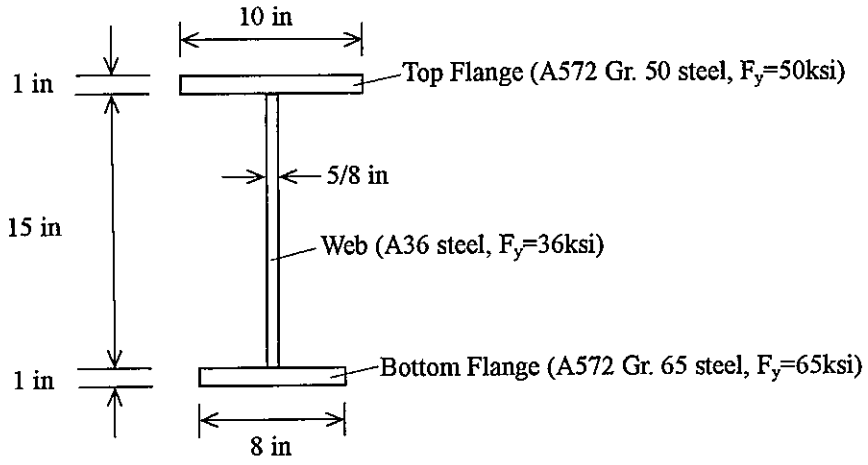
3. (20%) Explain the following terminologies regarding the mechanical properties of steel.
   (a) Snoek peak
   (b) Blue brittleness
   (c) Luders band
   (d) Ferrite, cementite and pearlite

4. (20%) Please explain *tangent modulus theory*, *reduced modulus theory* (also referred to as *double modulus theory*) and *Shanley's theory* for buckling of inelastic columns, and compare these three theories.

5. (15%) Please derive the elastic buckling load P_{cr} for the following fixed-free column. Note that the material of the column is linearly-elastic.



6. (15%) Consider the following steel beam:



Please compute:

(1) The first yield moment M_y of this beam

(2) The plastic moment M_p of this beam

Construction Schedule and Control Ph.D. Qualification Exam 10/28/2011

1. For the following job, please calculate early and late times (ES, EF, LS, and LF) for each activity, draw the network, and identify the critical path. (Activities are not split.) (30 points)

Activity	Duration	Successor	Relationship and lag
A	6	B	SS2
		C	SF4,8
B	8	C	FF1
		E	FS2
C	10	D	SS4, FF2
D	12	E	FF7
		H	FS0
E	10	G	SS6, FF5
		H	FS1
		F	SS2, FF2
G	10	H	FF4
H	8		
F	10		

2. Please use a project as an example to simulate schedule planning and control. Start from WBS, propose activities, prepare planned schedules, update them during construction, and evaluate schedule performance. (30 points)

3. What are the advantages and disadvantages of the bar chart and network techniques? Under what conditions are they more applicable or better used? (20 points)

4. A project' s work data are shown in the first table below. Assume the project proceeded to 4/30, please fill in the spaces in the second table and the equations below. (20 points)

Activity	Start time	Finish time	Duration	Budget
A	4/16	4/22	5	12,500
B	—	—	2	5,000
C	4/30	—	2	5,000
D	4/23	4/29	4	10,000

Activity	% complete	BCWS	BCWP	ACWP	SPI	CPI	Good or bad
A	100	12,500		10,000			
B		0	0	0			
C		5,000		3,000		0.83	
D			10,000	12,000	1.0		
Total							

Estimated cost at completion = _____ Equation = _____

Engineering Management Information System, Qualification (2011)

1. Given the following business rules, create the appropriate E-R diagram according to the following the specified relationships: (20%)
   A company operates four departments.
   Each department employs employees.
   Each of the employees may or may not have one or more dependences.

2. The following table structure contains may unsatisfactory components and characteristics (for example, there are several multi-valued attributes, naming conventions are violated, some attributes are not atomic, and so on)

ATTRIBUTE_NAME	Sample Value
EMP_CODE	1003
LAST_NMAE	Wilaker
EDUCATION	HS, BBA, MBA
DEPT_CODE	MKTG
DEPARTMENT	Marketing
DEPT_MANAGER	Jill H. Martin
JOB_CLASS	23
TITLE	Sale agent
DEPENDENTS	Gerald (spouse), Mary (daughter), John (son)
BIRTH_DATE	12/23/65
HIRE_DATE	10/14/94
TRAINING	level 1, level 2
BASE_SALARY	$32,225

   2.1. Given this structure, draw its dependence diagram. Label all transitive and /or partial dependences. (15%)
   2.2. Break up the dependency diagram to produce dependency diagram that are in 3NF. (Hint: you might have to create a few new attributes.)(15%)
   2.3. Using the results of problem 2.3, complete the E-R diagram which can show the relationships and the connectivity. (15%)

3. What is the primary key of the Table 1? why? (15%)

Table 1

A	B	C
a11	b11	c11
a12	b11	c12
a12	b12	c13
a11	b12	c12
a12	b13	c13
a11	b13	c13

工程時程控制　博士資格考　100 年 10 月 28 日

一、某工作有下列作業與關係，請針對作業不分裂(split)，計算各作業最早、最晚時間，劃出網圖，指出要徑。(30 分)

作業	工期	後續作業	關係延時
A	6	B	SS2
		C	SF4,8
B	8	C	FF1
		E	FS2
C	10	D	SS4, FF2
D	12	E	FF7
		H	FS0
E	10	G	SS6, FF5
		H	FS1
		F	SS2, FF2
G	10	H	FF4
H	8		
F	10		

二、請自行舉一案例，模擬時程的規劃與控制。從 WBS 開始分解工作，作出網圖或桿狀圖預定進度表，工作進行中的進度更新，如何評估績效等，說明重點。(30 分)

三、請問幹狀圖與網圖的優、缺點如何？各適用情況如何？ (20 分)

四、某工程開挖至 4/30，其作業資料如下表一，請填入第二表中及表下空格。(20 分)

作業	敘述	開始時間	完成時間	原工期	預算
11	開挖 A	4/16	4/22	5	12,500
12	開挖 B	—	—	2	5,000
13	開挖 C	4/30	—	2	5,000
14	開挖 D	4/23	4/29	4	10,000

作業	完成 %	BCWS	BCWP	ACWP	SPI	CPI	好 or 差
11	100	12,500		10,000			
12		0	0	0			
13		5,000		3,000		0.83	
14			10,000	12,000	1.0		
合計							

預估完工金額 = _____　　算式 = _____