NCKU 1011 Qualify Exam for Ph.D. Candidate
Course: Soil mechanics
Time limitation: 100 min.

Note: Make rational assumptions if necessary

Question 1: briefly explain the following terms: (25 pts)

(a) Critical state
(b) K_0-condition
(c) Diffuse double layer
(d) Newmark's influence chart
(e) Flow net

Question 2: questions related to physical properties of soils; (25 pts)

(a) List the three major clay minerals and compare the activity and shrinkage limit.
(b) List the physical properties required for USCS soil classification and explain why these properties are involved.
(c) Explain the physical meanings of A-line and U-line in Casagrande plasticity chart.
(d) Show that $e = \dfrac{\gamma_{sat} - \gamma_d}{\gamma_d - \gamma_{sat} + \gamma_w}$ with three phase diagram.

Question 3: problems related to water in soils: (25 pts)

(a) Describe the Darcy's law and list the validation conditions.
(b) Derive the governing equation for 2D steady flow in anisotropic soils.
(c) Use the flow net of Fig. 1 for the dam with 120 m in length to calculate the quantity of seepage loss under the dam with isotropic

$k_h = k_v = 4 \times 10^{-4}$ cm/s and anisotropic $k_h = 4k_v = 4 \times 10^{-4}$ cm/s.

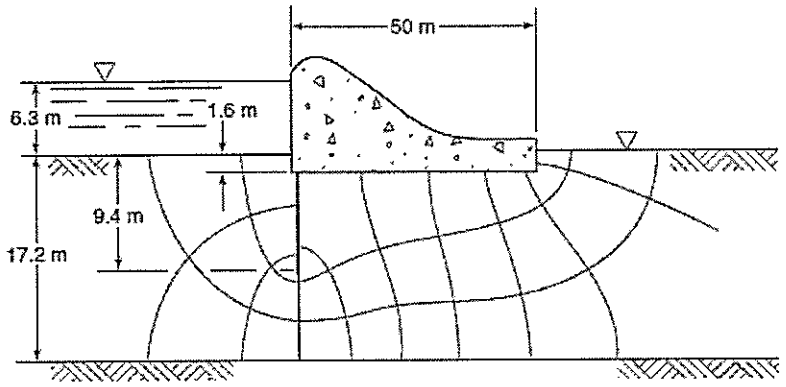


Fig. 1

Question 4: questions related to shear strength of soils: (25 pts)

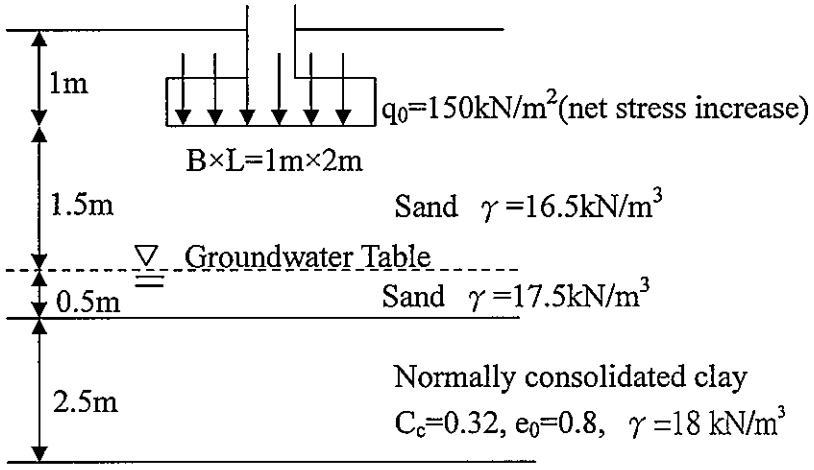
(a) For a soil with strength parameters (c, ϕ), derive the following relationship for principles stresses at failure: $\sin\phi = \dfrac{(\sigma_{1f} - \sigma_{3f})}{(\sigma_{1f} + \sigma_{3f}) + 2c\cot\phi}$.

(b) A SCU test on NC clay yielded the following results: effective consolidation pressure, $\sigma_3 = 100$ kPa; deviator stress at failure, $\Delta\sigma_{d,f} = 76$ kPa; and excess pore pressure at failure, $\Delta u_{d,f} = 50$ kPa. Calculate the total and effective strength parameters of the soil.

(c) Plot the stress path of (b) along with K_f-line.

Foundation Engineering

1. Describe the way to determine the minimum depth of the borings during the subsurface exploration program. (10%)
2. Define the recovery ratio (5%) and the rock quality designation (RQD) (5%)
3. Plot the figure of bearing capacity failure in soil under a rough rigid continuous foundation and write down the name of each zone in the figure (10%)
4. Define the Standard Penetration Test (5%)
5. A plan of a foundation 1m×2m. Estimate the consolidation settlement of the foundation by 2:1 method.(10%)



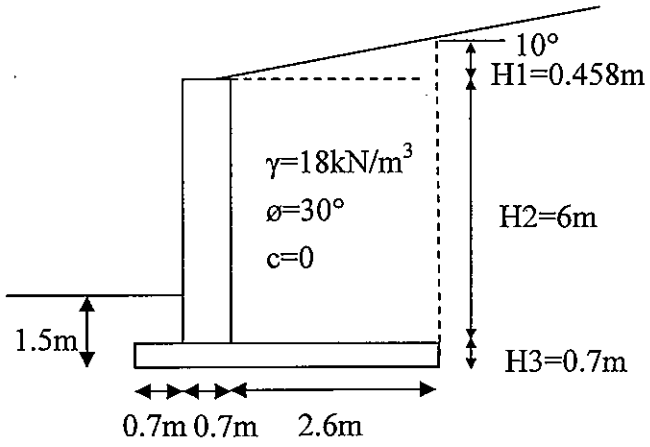
6. Describe the process to calculate the ultimate bearing capacity under eccentric loading-one-way eccentricity based on Effective Area Method proposed by Meyerhoff. (10%)
7. A mat foundation is constructed in the saturated clay (C=Cu=30kN/m2 , ø=0). The length of the foundation L=12 m and the width B=10 m. The vertical force applied to the foundation is 200MN. The unit weight of the clay is 18.9 kN/m3.
   (a) Determine the depth of the foundation D_f if the foundation is fully compensated foundation. (10%)
   (b) Determine the depth of the mat foundation if the safety factor of the bearing

capacity is assumed to be 3.0. (10%)

Hint: $q_{all(net)}=5.14C_u[1+0.195(B/L)][(1+0.4D_f/B)]$

8. Assume the horizontal backfill soils have the unit weight γ, the shear strength parameters c and ø. Derive the formula of Rainking active earth pressure at the depth of z based on Mohr circle and the Mohr-Coulomb failure criteria. (5%). In addition, when the retaining wall has the height of 6 m. The backfill soils are clay with γ=15.72kN/m3 , cu=6.77kN/m2 , ø=30°. What is the maximum depth of the tension crack in the backfill soils (10%).

9. Assume that the soils at the both sides of the retaining wall are the same. Calculate the safety factors of the concrete retaining wall with overturning and sliding. [Hint: The unit weight of the concrete =23kN/m3. No discount of the c and ø is concerned in the calculations.] (10%)



101 年度第一學期博士候選人資格考工程地質試題

一、Translate following terminologies to Chinese and explain their meanings: (25%)

(1) holocene
(2) unconformity
(3) bedding
(4) RQD
(5) primary weak plane

二、Distinguish among a joint, a fault, and a fold. How are they formed ? What are their effects on the rock mass ? (25%)

三、(1) Draw a figure to explain the meaning of strike, dip and dip direction. (9%)
(2) Use the expression of dip direction/dip to show the following three sets of discontinuities。(9%)

（a）N35°E，40°SE
（b）N35°E，40°NW
（c）S35°W，40°NW

(3) Determine the angle between set (a) and (c), also the angle between set (b) and (c) ? (6 %)

四、(1) List three most popular rock mass classifications used in rock engineering?
(2) Describe the parameters used in the Rock Mass Rating (RMR) system (Bieniawski, 1973)。 (26%)

101 學年度第一學期博士學位候選人資格考試

Advanced Bituminous Materials

高等瀝青材料學 (20% for each question)

1. Translate the following paragraph.
   Asphalt cement is one of man's oldest engineering materials. Its adhesive and waterproofing properties have been known since early civilization. It was used by a thriving shipbuilding industry in Samaria about 6000 B.C. As early as 2600 B.C, Egyptians used native asphalts for waterproofing, mummification, and building structures. The use of naturally occurring asphalts as a mortar for building and paving blocks, caulking for ships, and numerous waterproofing applications continued in later years in various parts of the world.

2. Briefly describe the asphalt cement grading system.

3. Briefly describe the reasons to develop the superpave asphalt binder tests and specifications.

4. Briefly describe the procedures of the superpave mix design method.

5. Briefly describe the two principal types of HMA facilities (mixing plants).

Financial and Cost Concepts for Construction
Qualification Exam 10/26/2012

1. Explanations of terms (20 points)
   (1) Job order costing (3) Activity-based costing
   (2) Overhead (4) Internal rate of return

2. For the following transactions (30 points).
   (1) 8/5 Owner takes out $100,000 cash to establish a laundry store.
   (2) 8/6 Rents of Aug, Sep and Oct. are prepaid in $9,000 cash.
   (3) 8/7 Purchase laundry equipment $30,000 on credit from Company A.
   (4) 8/8 Purchase laundry material $3,000 by cash.
   (5) 8/15 Revenue of the 1st half month Aug. $10,000, but $8,000 on credit, $2,000 cash.
   (6) 8/19 Pay back $15,000 cash to Company A.

Please
   (1) Make journal entries 做分錄
   (2) Post entries into T accounts 過帳
   (3) Prepare the income statement of August 做 8 月份損益表
   (4) Prepare the balance sheet of August (increase and decrease) 做 8 月份資產負債表 (增減多少)

3. A company reported the income statement and balance sheet for 2011 and 2010 on the next page. Please prepare A company's statement of cash flows for the year ended Dec. 31, 2011, by the indirect method. (30 points)

4. Please calculate and compare the following ratios for the two years for A Company on the next page: (20 points)
   (1) Current ratios,
   (2) Days' sales in receivables,
   (3) Debt ratios, and
   (4) Rate of return on Common stockholders' equity.

Financial and Cost Concepts for Construction
Qualification Exam 10/26/2012

Income Statement

Year Ended Dec. 31, 2011

Sales revenue		$700
Cost of goods sold		600
Gross profit		100
Operating expenses:		
Salary expense	50	
Rent expense	5	
Depreciation expense	10	
Total operating expense		65
Income from operations		35
Loss on sale of equipment		(3)
Income before income tax		32
Income tax expense		16
Net income		16

Balance Sheet

Dec. 31, 2011 and 2010

Asset	2011	2010	Liabilities	2011	2010
Current:			Current:		
Cash and equivalents	$20	3	Accounts payable	35	26
Accounts receivable	20	22	Accrued liabilities	7	9
Inventories	40	30	Income tax payable	10	10
Total CA	80	55	Total CL	52	45
Equipment	130	70	Bonds payable	84	53
			Owner's Equity		
			Common stock	52	20
			Retained earnings	27	19
			Less: Treasury stock	(10)	(5)
Total assets	210	125	Total liabilities and equity	205	132

Transactions data for 2011:

Purchase of equipment	$140
Payment of dividends	18
Issuance of common stock to retire bonds payable	13
Issuance of bonds payable to borrow cash	44
Cash receipt from issuance of common stock	19
Cash receipt from sale of equipment (book value, $76)	74
Purchase of treasury stock	5

Qualification CMIS 2012

1. James must decide which courses to register for this semester. He has a part-time job, and he is waiting to find out how many hours per week he will be working during the semester. If he works 10 hours or less per week, he will register for three classes, but if he works more than 10 hours per week, he will register for only two classes. If he registers for two classes, he will take one class in his major area and one elective. If he registers for three classes, he will take two classes in his major area and one elective.
   1.1. Use structured English to represent this logic. (10%)
   1.2. Use decision table to represent this logic. (10%)

2. Describe what total specialization, partial specialization, disjoint, and overlap rules are. Give an example for each of them. (15%)

3. What are the differences between Structured Query Language and Query By Example? (10%)

4. Use the following dependencies to normalize Table 1 to 3rd normal tables. (15%)
   (A, B) → C, D, E, F, G
   B→D, E, F
   C→B
   E→F

Table 1

A	B	C	D	E	F	G

5. Use the following business rules to answer the questions:
   a. A department employs many employees, but each employee is employed by one department.
   b. Some employees, know as "Rover," are not assigned to any department.
   c. A division operates many departments, but each department is operated by one division.
   d. An employee may be assigned to many projects and a project may have many employees assigned to it.
   e. A project must have at least one employee assigned to it.
   f. One of the employees manages each department.
   g. One of the employees runs each division.

   5.1. Develop an appreciate E-R diagram (20%)
   5.2. Write all the cardinalities into the model.(10%)
   5.3. Modify the E-R model by splitting the M:N relationship into two 1:M relationships that are connected through a composite entity. Then rewrite the connectivities and cardinalities to match the changes you have made.(10%)

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. What are the principles of determining work breakdown structure (WBS) (15%)

3. Figure 1 shows a six-month schedule for a project. After three months on the job (July 1), the contractor concluded that 20% of Activity F (Activities A, B, and D are completed) was completed, 80% of Activity C was completed, and 40% of Activity E was completed. The contractor has spent a total of $550 on the project at the time of July 1. (15%)

3.1. For this project, using earned value concepts, determine the ACWP, BCWP, BCWS, SPI, and CPI.
3.2. Explain if the project is over or under budget and if it is ahead of or behind schedule

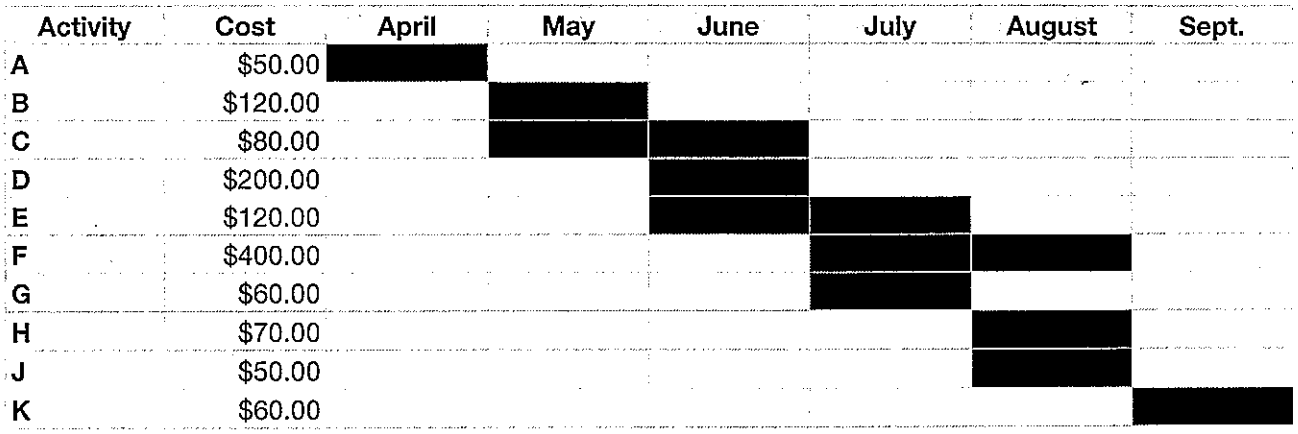


Figure 1

4. 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.**
4.1. Develop a linear schedule for this project and determine the project duration(10%)
4.2. 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

5. Please level the resources (R) for the network in Figure 2. (20%)

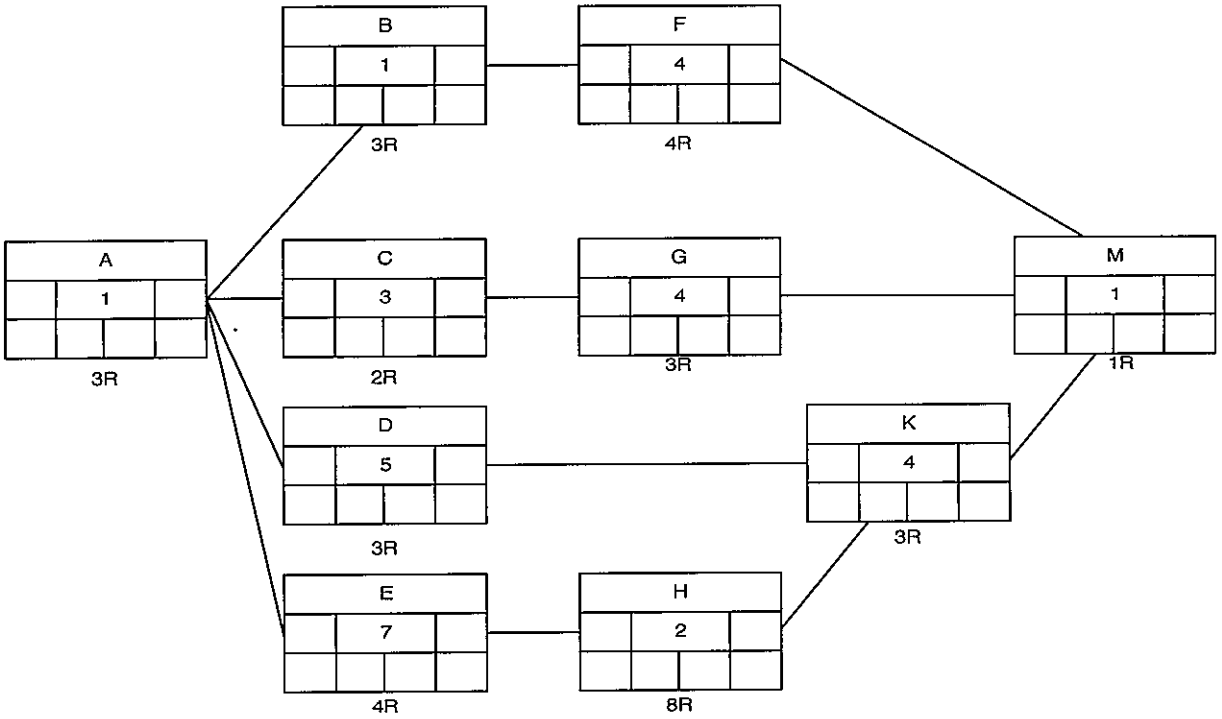


Figure 2