3-1

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring-2017
Program: B.Sc. Engg (3rd year 1st semester)

Course Title : Principles of Accounting   Course: ACN 301   Credit: 2.0
Time : 2 hours   Full marks : 50

[N.B.: There are Five questions in this paper Answer any four including Question-5 from the followings]

1.a) Define Journal. Identify the basic steps in the recording process. **2.5**

b) Joan Robinson opens her own law office on July 1, 2010. During the first month of operations, the following transactions occurred. **10**

1. Joan invested $11,000 in cash in the law practice.
2. Paid $800 for July rent on office space.
3. Purchased office equipment on account $3,000.
4. Provided legal services to clients for cash $1,500.
5. Borrowed $700 cash from a bank on a note payable.
6. Performed legal services for client on account $2,000.
7. Paid monthly expenses: salaries $500, utilities $300, and telephone $100.
8. Joan withdraws $1,000 cash for personal use.
9. Collected cash of $1200 for services billed in transaction (6).
10. Received advance $3000 in cash from customers for legal services, will perform in next month.

Instructions:

a) Journalize the Transactions.

b) Post the journal entries to the accounts on Cash A/C, Service Revenue, Account Receivables and Owners Drawings.

2.a) Explain the accrual basis of accounting. Differentiate between accrual basis and cash basis accounting. **2.5**

b) Neosho River Resort opened for business on June 1 with eight air-conditioned units. Its trial balance before adjustment on August 31 is as follows. **10**

NEOSHO RIVER RESORT
Trial Balance
August 31, 2010

	Debit	Credit
Cash	19,600	
Supplies	3,300	
Prepaid Insurance	6,000	
Land	25,000	
Cottages	125,000	
Furniture	26,000	
Accounts Payable		6,500
Unearned Rent Revenue		7400
Mortgage Payable		80,000
P. Harder, Capital		100,000
P. Harder, Drawing	5,000	
Rent Revenue		80,000

Repair Expense	3,600	
Salaries Expense	51,000	
Utilities Expense	9,400	
Total	273,900	273,900

Other data:

1. Insurance expires at the rate of $400 per month.
2. A count on August 31 shows $600 of supplies on hand.
3. Annual depreciation is $6,000 on cottages and $2,400 on furniture.
4. Unearned rent revenue of $4,100 was earned prior to August 31.
5. Salaries of $400 were unpaid at August 31.
6. Rentals of $1,000 were due from tenants at August 31. (Use Accounts Receivable.)
7. The mortgage interest rate is 9% per year. (The mortgage was taken out on August 1.)

Instructions:
(a) Prepare the adjusting entries August 31 for the 3-month period June 1–August 31.
(b) Prepare an adjusted trial balance on August 31.

3.a) The income statement of Fezzik's Shoe Repair is as follows: **5**

FEZZIK'S SHOE REPAIR
Income Statement
For the Month Ended April 30, 2014

Revenue		
Service Revenu		$9,500
Expenses		
Salaries and Wages Expense		$4,200
Depreciation Expense		350
Utilities Expense		400
Rent Expense		600
Supplies Expense		1,050
Total Expenses		6,600
Net Income		**$2,900**

On April 1, the Owner's Capital account had a balance of $12,900. During April, Fezzik withdrew $3,000 cash for personal use.

Instructions:
(a) Prepare closing entries at April 30.
(b) Prepare an owner's equity statement for the month of April.

7.5

b) These financial statement items are for Rugen Company at year-end, July 31, 2014.

Salaries and wages payable	$ 2,980	Notes payable (long-term)	$ 3,000
Salaries and wages expense	45,700	Cash	5,200
Utilities expense	21,100	Accounts receivable	9,780
Equipment	38,000	Accumulated depreciation	6,000
Accounts payable	4,100	Owner's Drawings	4,000

Service revenue	57,200	Depreciation expense	4,000
Rent revenue	6,500	Owner's capital (beginning of the year)	48,000

Instructions

(a) Prepare an income statement and an owner's equity statement for the year. The owner did not make any new investments during the year.

(b) Prepare a classified balance sheet at July 31.

4.a) Answer the following questions: **5**

i. Define Temporary Account and Permanent Account with Examples.

ii. Explain Revenue Recognition and Matching Principle.

b) The adjustments columns of the worksheet for Mandy Company are shown below. **7.5**

Account Titles	Adjustments Debit	Adjustments Credit
Accounts Receivable	800	
Prepaid Insurance		650
Accumulated Depreciation		770
Salaries and Wages Payable		1,200
Service Revenue		800
Salaries and Wages Expense	1,200	
Insurance Expense	650	
Depreciation Expense	770	
	3,420	3,420

Instructions:

(a) Prepare the adjusting entries.

(b) Assuming the adjusted trial balance amount for each account is normal, indicate the financial statement column to which each balance should be extended.

5.a) At the end of its first month of operations, Watson Answering Service has the following unadjusted trial balance. **10**

WATSON ANSWERING SERVICE
August 31, 2010
Trial Balance

Account Name	**Debit**	**Credit**
Cash	$5400	
Account Receivable	2400	
Supplies	2800	
Prepaid Insurance	1300	
Equipment	60000	
Notes Payable		$40,000
Account Payable		2,400
Watson Capital		30,000
Watson Drawing	1,000	
Service Revenue		4,900
Salaries Expense	3,200	
Utilities Expense	800	
Advertising Expense	400	
Total	77,300	77,300

Other data:

1. Insurance expires at the rate of $200 per month.
2. $1,000 of supplies is on hand at August 31.
3. Monthly depreciation on the equipment is $900.
4. Interest of $500 on the notes payable has accrued during August

Instructions :

(a) Prepare a worksheet.

(b) Prepare an Income Statement, Owner's Equity Statement and classified balance sheet assuming $35,000 of the notes payable is long-term.

b) Journalize the Correcting Entries for the following transactions:

1) Jawbreaker Company paid $940 on account to a creditor. The transaction was erroneously recorded as a debit to Cash of $490 and a credit to Accounts Receivable, $490. **2.5**
2) A lawyer collected $710 of legal fees in advance. He erroneously debited Cash for $170 and credited Accounts Receivable for $170.
3) On May 25, Yellow House Company received a $650 check from Grizzly Bean for services to be performed in the future. The bookkeeper for Yellow House Company incorrectly debited Cash for $650 and credited Accounts Receivable for $650. The amounts have been posted to the ledger.
4) On March 8, Black Candy Company bought supplies on account from the Arcade Fire Company for $550. Black Candy Company incorrectly debited Equipment for $500 and credited Accounts Payable for $500. The entries have been posted to the ledger.

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I — Course Code: CE 341
Time: 3 hours — Full Marks: 100

PART A

Answer the following questions. **50 = (10 + 15 + 25)**

1. (i) Judge that the soil classified as 'sand' in Fig.1 is correct according to Unified Soil Classification System (USCS). Determine the symbol for the soil by applying USCS. The particle size distribution curves are attached. 8

(ii) Identify the probable classifications according to USCS for the soil named 'clay' in Fig. 1. 2

2. Apply Rankine's theory of lateral earth pressure for the following questions:

(i) Compute the magnitude of lateral force (per unit length of the wall) acting on the earth retaining structure, shown in the following figure. Given that the backfill soils push the retaining wall. Consider up to the dredge line. 8

(ii) Modify the lateral force when water table is at the ground level. 3

(iii) Modify the lateral force, if soils of both the layers have 10 kPa of cohesion, while other parameters remain the same. Consider that water table is at the ground level. 4

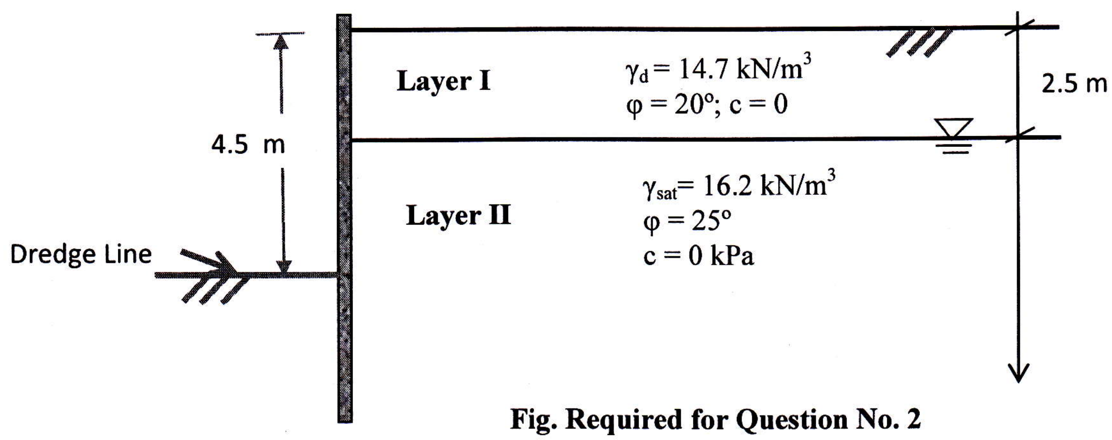


Fig. Required for Question No. 2

3. **Answer Question 3(a) or 3(b)**

3(a) (i) A square footing (2 m x 2 m), in the soil profile in Fig. 3, transmits a pressure of 200 kN/m^2 at the footing base. Compute the increase in vertical stress ($\Delta\sigma$) at the mid depth of 3 m thick clay layer below the centre of the footing using both the methods: 4 + 4

- Influence factor
- Equivalent point load method

Given that

$$\sigma_z = \frac{3Q}{2\pi} \cdot \frac{z^3}{(r^2 + z^2)^{5/2}}$$

(ii) Estimate the over-consolidation ratio (OCR) for a soil element at the mid- depth of the clay layer in situ condition (i.e., before increase in stress). 3
Given that pre-consolidation pressure of the clay layer = 125 kPa.

(iii) Predict the primary consolidation settlement of the clay layer for the maximum stress increase obtained in (i). 11
Compression index, $C_c = 0.25$, pre-consolidation pressure of the clay layer = 105 kPa

(iv) Predict the time for the clay layer to settle 10 mm due to increase in stress from the footing. 3
Given that coefficient of consolidation, $c_v = 0.25\ mm^2/s$

$$T_v = \frac{\pi}{4} \cdot \left(\frac{U}{100}\right)^2$$

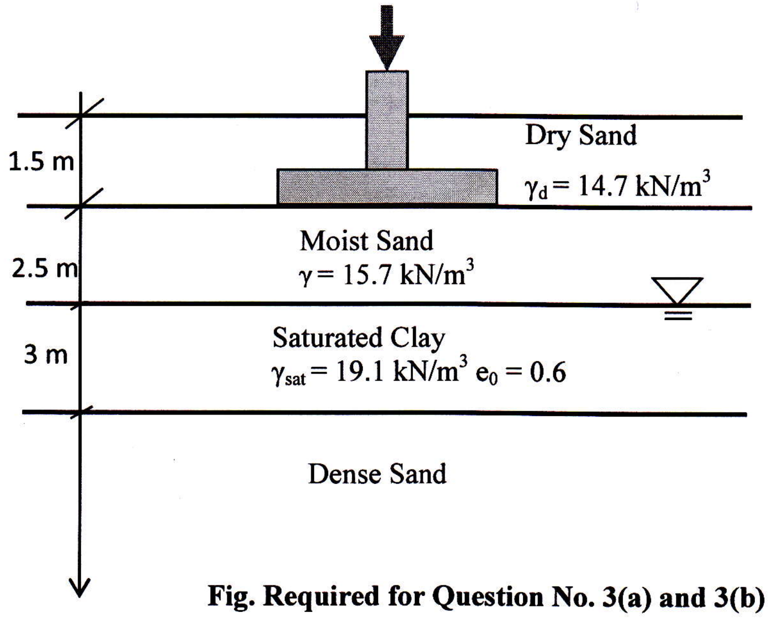


Fig. Required for Question No. 3(a) and 3(b)

3(b) (i) A square footing (2 m x 2 m), in the soil profile shown in Fig. 3a, transmits a pressure of 200 kN/m^2 at the footing base. Determine the increase in vertical stress ($\Delta\sigma$) at layer at points 'A' and 'B' (Fig. 3b). Both the points are at 4 m below the footing base. The chart for influence factor is given. 8

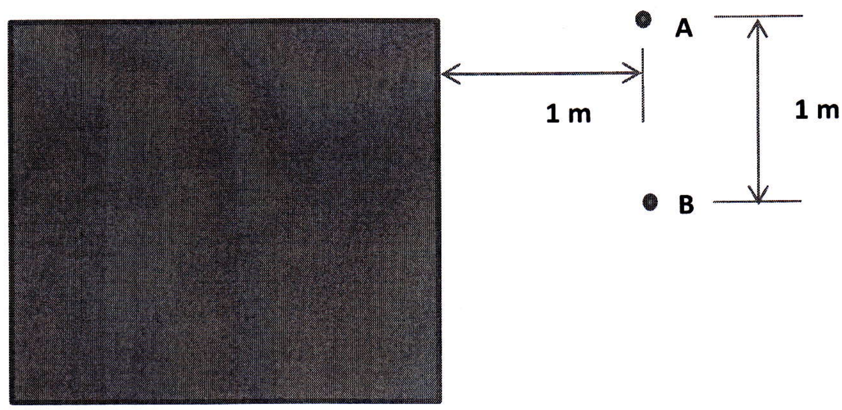


Fig. Required for Question No. 3(b)

(ii) Calculate the over-consolidation ratio (OCR) for a soil element at point 'B' which is at the mid- depth of the clay layer after the increase in stress due to the load transmitted by the foundation. 3
Given that pre-consolidation pressure of the clay layer = 90 kPa.

(iii) Estimate the primary consolidation settlement of the clay layer for the stress increase at Point 'A'. Given that pre-consolidation pressure of the clay layer = 90 kPa. 11

During loading stage of soil sample in normally consolidated condition in one-dimensional consolidation test setup, the following data are obtained:

Effective stress (kN/m^2)	Void Ratio
375	0.57
450	0.48

(iv) During one-dimensional consolidation test, a 2 cm thick clay specimen from point 'A' takes 45 hours to reach 45% degree of consolidation.
Determine the time required by the clay layer at point 'A' in field to reach 45% consolidation. 3

PART B

Answer the following questions. **50**

= (20 + 20 + 10)

4. Answer Question 4(a) or 4(b)

4(a).

The shear force versus displacement curves obtained from direct shear tests are presented in Fig. 4a. Given that the size of the shear box is 60 mm by 60 mm.

(i) Interpret the results for estimating the shear strength parameters both for peak and ultimate shear strengths of the soil. Use graph paper for constructing Mohr-Coulomb failure envelopes. 15

(ii) Sketch the typical shape of axial displacement versus shear displacement relation for the soil's angle of internal friction obtained from the direct shear test results. 5

4(b) The results of three CU triaxial tests were given.

(i) Construct effective stress Mohr-circles and Mohr Coulomb failure envelop. Use graph paper. Interpret the results for estimating shear strength parameters (effective stress analysis). 15

(ii) If a cohesionless soil sample was tested under a confining pressure of 375 kPa and failed at a deviatoric stress of 225 kPa, compute the angle of internal friction. 5

CU Triaxial Test Results (Required for Question No. 4(b)

Test No.	Confining Pressure (kPa)	Deviator Stress (kPa)	Pore water pressure (kPa)
1	300	151	216
2	375	225	229
3	450	260	303

5. A flownet is drawn (Fig.5) for calculring seepage flow underneath the dam.

(i) Estimate the flow rate of water under the dam. Assume $k = 2 * 10^{-4}$ cm/s. 5

(ii) Compute the uplift pressures (kPa) along the base of the dam. 5

(iii) Compute the hydraulic gradient. 3

(iv) Select a measure for reducing the uplift pressure along the base of the dam. Justify your proposal. 3

(v) Explain the necessity to take measures so that less water pressure can develop at the base of the dam. 4

6. The compaction curve obtained from the analysis of standard Proctor test results is given.

(i) Interpret the compaction curve to predict the optimum moisture content and the maximum dry density. 2

(ii) Set up the range of moisture content for field compaction. 2

(iii) Can it be possible to attain density greater than $\gamma_{d(max)}$? If yes, how can it be achieved? 3

(iv) Judge the following statement based on the compaction curve given.
90% of $\gamma_{d(max)}$ can be achieved if moisture content is 4% less than optimum moisture content. 3

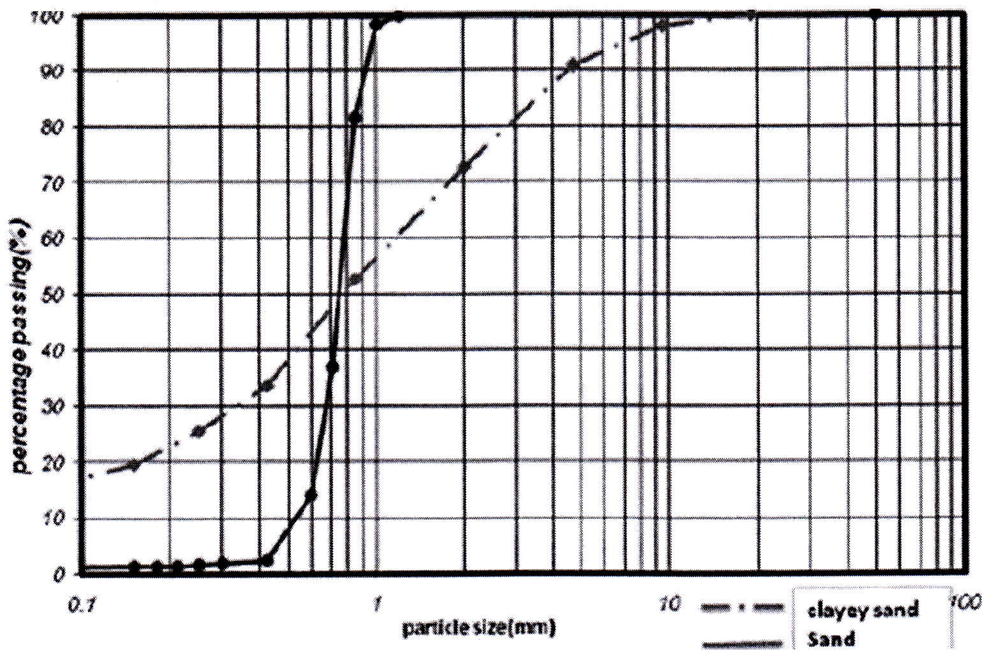


Fig. Required for Question No. 1

Table: Influence factor chart (For Question No. 3)

n	m							
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.1	0.005	0.009	0.013	0.017	0.020	0.022	0.024	0.26
0.2	0.009	0.018	0.026	0.033	0.039	0.043	0.47	0.050
0.3	0.01323	0.02585	0.03735	0.04742	0.05593	0.06294	0.06858	0.07308
0.4	0.01678	0.03280	0.04742	0.06024	0.07111	0.08009	0.08734	0.09314
0.6	0.02223	0.04348	0.06294	0.08009	0.09473	0.10688	0.11679	0.12474

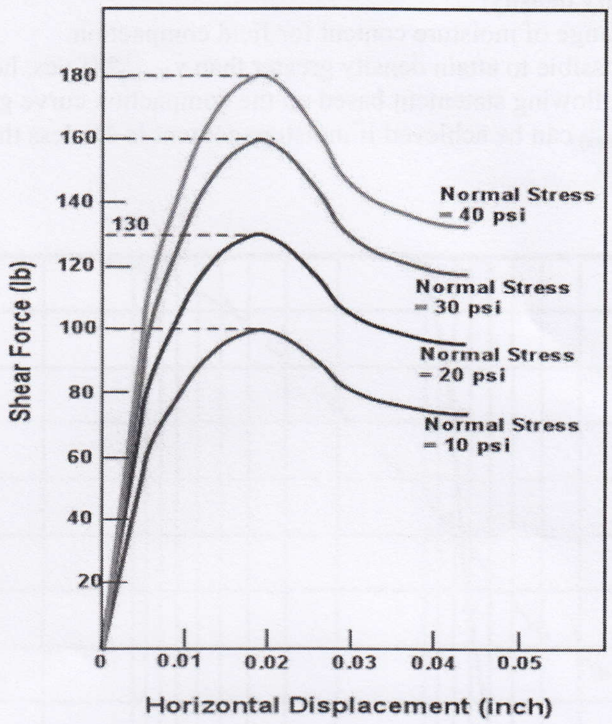


Fig. Required for Question No. 4a

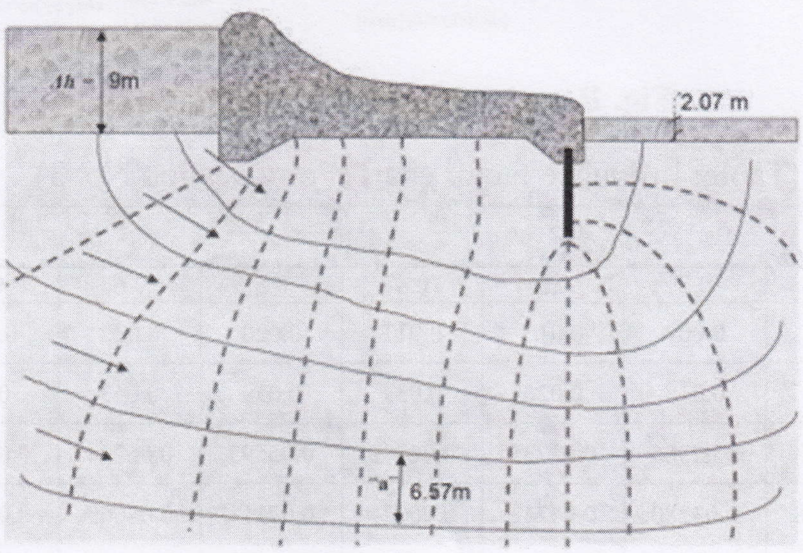


Fig. Required for Question No. 5

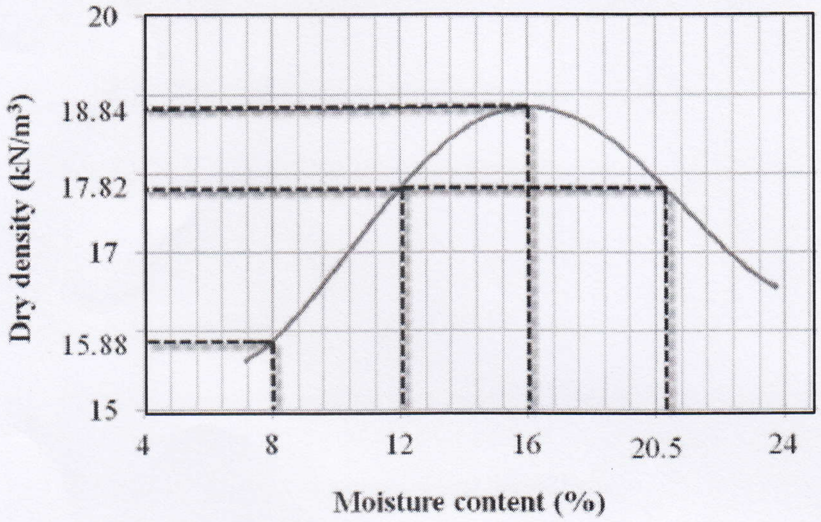


Fig. Required for Question No. 6

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B. Sc. Engineering (Civil)

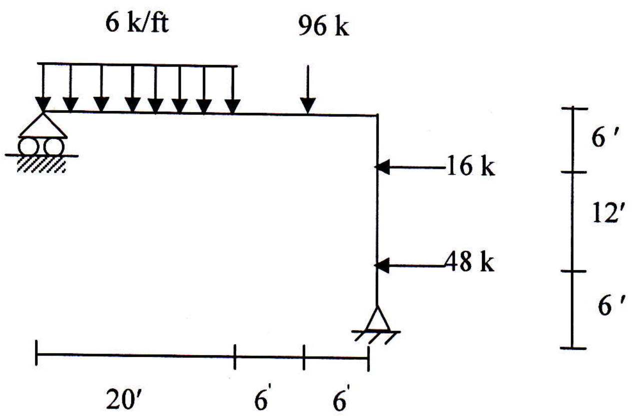
Course Title: Structural Engineering I
Time: 3.00 Hours

Course Code: CE 311
Full Marks: 100 (=10×10)

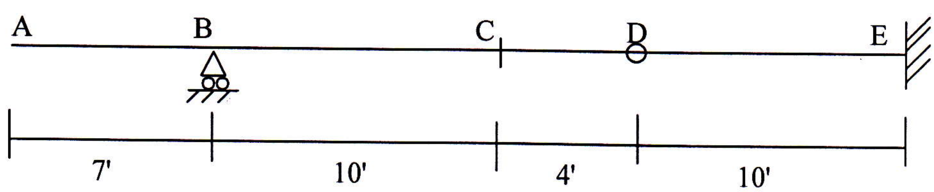
Part A

*There are **five (05)** questions in this part. Answer any **four (04)**.*
Assume any missing data reasonably.

1. Draw the shear force and bending moment diagrams for the structure shown in the figure below. [10]

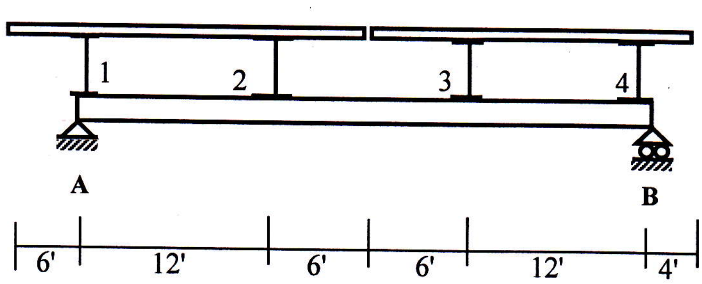


2. For the beam shown below, draw Influence lines for (i) Reaction at B, (ii) Shear at D, (iii) Shear just right of B (iv) Vertical reaction at E and (v) Moment at C. [10]

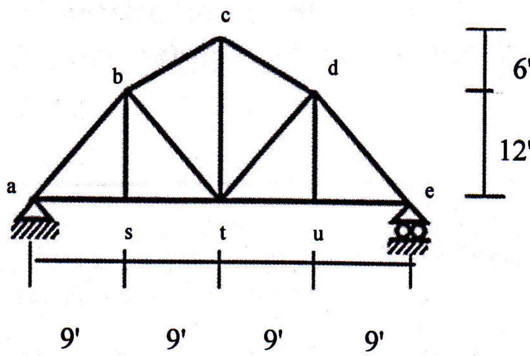


3. Girder AB supports a floor system as shown in the figure below. Draw the Influence lines for [10]

(i) Floor beam reaction at panel point "1" and "2"
(ii) Support reaction at "A"
(iii) Shear in panel 1-2 and
(iv) Bending moment for girder at panel point "3".

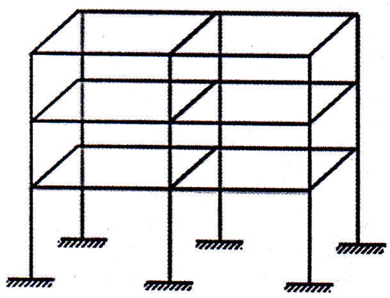


4. For the truss shown below, draw the influence lines for F_{bs}, F_{ab}, F_{as}, and F_{bt}. Note, each bottom chord joint consists of a cross girder and load moves over the floor beam placed over the girders. [10]

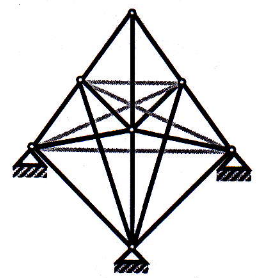


5. Determine whether the structures are statically and geometrically stable or unstable. [10]

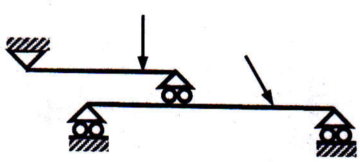
(a)



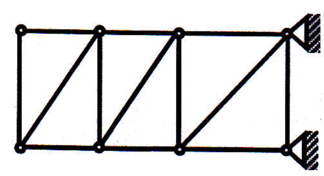
(b)



(b)



(d)

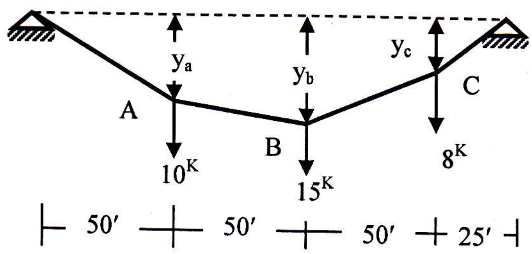


Part B

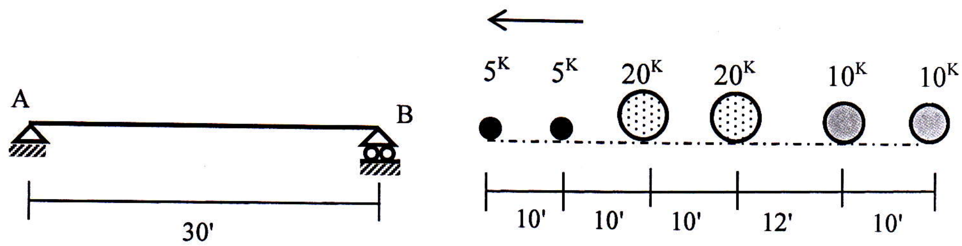
There are ***eight (08)*** *questions in this part. Answer any* ***six (06)****.*
Assume any missing data reasonably.

6. State and derive the General Cable Theorem. [10]

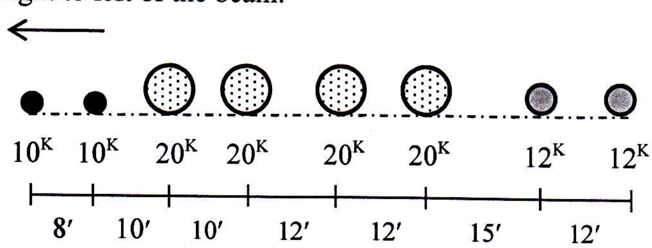
7. For the cable shown in figure below, calculate y_a, y_b and y_c and maximum cable tension. Given: Maximum Sag = 30′. [10]



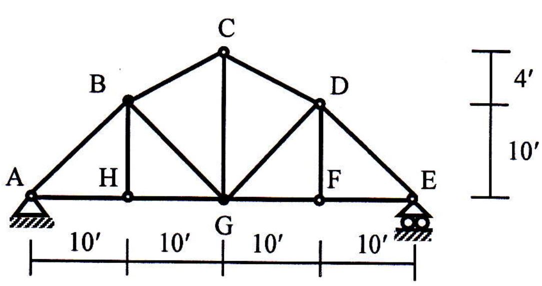
8. Calculate the maximum reaction at support A of the simply supported beam AB for the wheel loads arrangement shown below. [10]



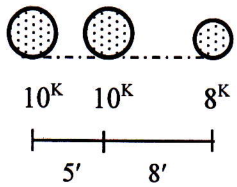
9. Compute the maximum shear at 20 feet away from the left support of a simply supported beam of 50′ span due to series of moving loads shown in the figure below. Load moves on the span from right to left of the beam.



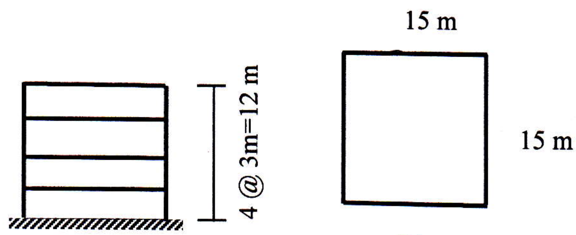
10. For the truss shown below, calculate the maximum axial force in members BC and HG for a uniformly distributed dead load of 2 k/ft and a concentrated live load of 20 k. [10]
[Note: Stringers are simply supported on floor-beams at bottom-cord joints].



11. Justify the following statement. [10]
"Maximum moment under any load will occur when that load and center of gravity of all loads on the simply supported beam are equidistant from the center of that beam."
Compute the absolute maximum moment in a 30′ simply supported beam for the wheel load arrangement shown in the the figure below.



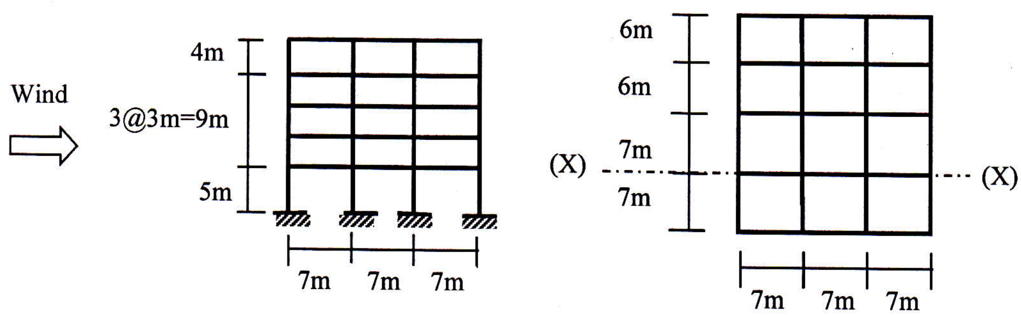
12. Calculate the seismic load at each story (i.e. at joints) of a four-storied concrete made residential building shown in the figure below located in Dhaka (Zone 2). Assume the structure to be a Special Moment Resisting Frame (SMRF), carrying a Dead Load including partition of 8 kN/m^2 and floor live load of 1 kN/m^2. [10]



Plan

Side Elevation

13. Calculate the wind load at frame X-X of a five-storied concrete made industrial building (shown below) located at a flat terrain in Rajshahi (Basic wind speed = 155 Kmph). Assume the structure to be subjected to Exposure B. [10]



Side Elevation

Plan

ANNEXURE

Earthquake

$$V = (ZIC/R)\,W$$
$$C = 1.25\,S/T^{2/3}$$
$$T = C_t\,(h_n)^{3/4}$$
$$F_x = (V - F_t)\,[w_x h_x / \Sigma w_i h_i]$$

Table: Site Coefficient for seismic Lateral forces

Soil Type	S
S_1	1
S_2	1.2
S_3	1.5
S_4	2

Table: Response Modification Coefficient for Structural Systems

Basic Structural System	Description of Lateral Force Resisting System	R
Moment Resisting Frame System	SMRF (steel)	12
	SMRF (concrete)	12
	IMRF	8
	OMRF (steel)	6
	OMRF (concrete)	5

C_t = 0.083 for steel moment resisting frames
= 0.073 for reinforced concrete moment resisting frames,
= 0.049 for all other structural systems

Z = 0.075, 0.15 and 0.25 for Seismic Zones 1, 2 and 3 respectively

Seismic Dead Load

Seismic dead load W is the total dead load of a building or a structure including permanent partitions. A minimum of 25 percent of the floor live load should be considered.

Wind

$$q_z = C_C\,C_I\,C_z\,V_b^2$$
$$p_z = C_G\,C_p\,q_z$$

Table: Structure Importance Coefficient

Category	C_I or I
Essential facilities	1.25
Hazardous facilities	1.25
Special occupancy	1.00
Standard occupancy	1.00
Low-risk structure	0.80

Table: Combined height and Exposure Coefficient

Height, z (m)	Combined Height and Exposure Coefficient, C_z		
	Exp A	Exp B	Exp C
0~4.5	0.368	0.801	1.196
6.0	0.415	0.866	1.263
9.0	0.497	0.972	1.370
12.0	0.565	1.055	1.451
15.0	0.624	1.125	1.517
18.0	0.677	1.185	1.573
21.0	0.725	1.238	1.623
24.0	0.769	1.286	1.667
27.0	0.810	1.330	1.706
30.0	0.849	1.371	1.743

Table: Overall Pressure Co-efficient (C_P) for rectangular buildings with flat roof

h/B	L/B					
	0.1	0.5	0.65	1.0	2.0	≥ 3.0
≤ 0.5	1.40	1.45	1.55	1.40	1.15	1.10
1.0	1.55	1.85	2.00	1.70	1.30	1.15
2.0	1.80	2.25	2.55	2.00	1.40	1.20
≥ 4.0	1.95	2.50	2.80	2.20	1.60	1.25

Table: Gust Response Factors

Height z (m)	C_G (for non-slender structures)		
	Exp A	Exp B	Exp C
0~4.5	1.654	1.321	1.154
6.0	1.592	1.294	1.140
9.0	1.511	1.258	1.121
12.0	1.457	1.233	1.107
15.0	1.418	1.215	1.097
18.0	1.388	1.201	1.089
21.0	1.363	1.189	1.082
24.0	1.342	1.178	1.077
27.0	1.324	1.170	1.072
30.0	1.309	1.162	1.067

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B. Sc. Engineering (Civil)

Course Title: Design of Concrete Structures I
Time: 3 hours

Course Code: CE 315
Full Marks: 70 (= 7× 10)

[Assume reasonable values for missing data]

Part I

[Answer any **three** (03) out of following **four** (04) questions]

1. Calculate the maximum bending stresses in concrete and steel in the beam section shown in Figure 1, Given $f_c' = 4$ ksi, $f_y = 60$ ksi, n = 8, M = 110 k-ft and f_r=475 psi. (10)

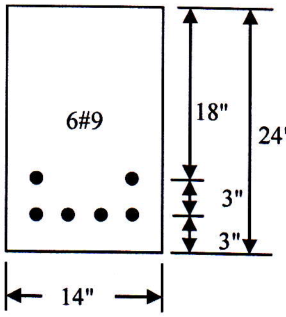
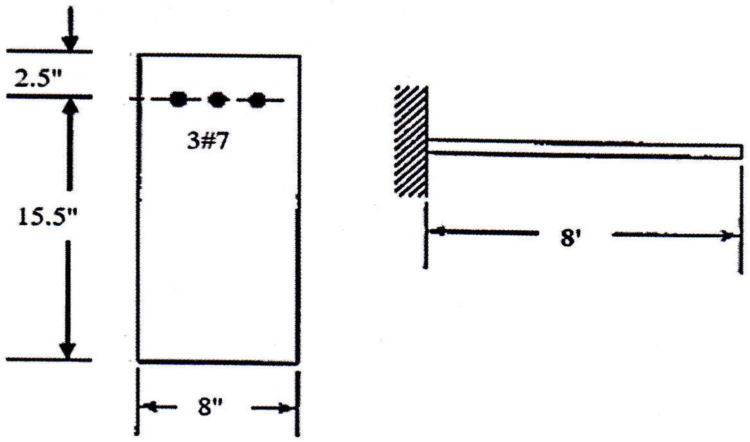


Figure 1

2. (a) An 8-ft span cantilever beam has a rectangular section and reinforcements as shown in Figure 2. For f'_c = 4 ksi, f_y = 60 ksi, check if the beam is safe to carry a dead load, including its own weight, of 1.5 k/ft and a live load of 0.9 k/ft. Use the USD/WSD method. (6)



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(b) Discuss the behavior of Reinforced Concrete beam section in flexure under increasing load by drawing neat sketches for strain and stress distribution of uncracked, cracked and ultimate conditions. (4)

3. (a) What are the recommendations of ACI code regarding the minimum and maximum permissible reinforcement in beams? Explain the necessity for these. (3)

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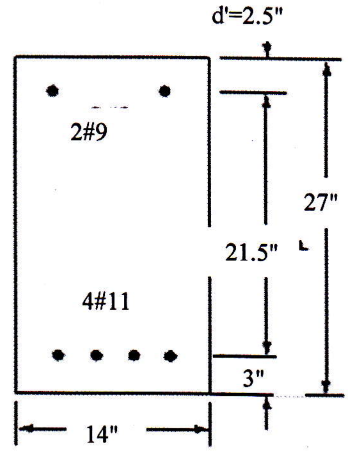

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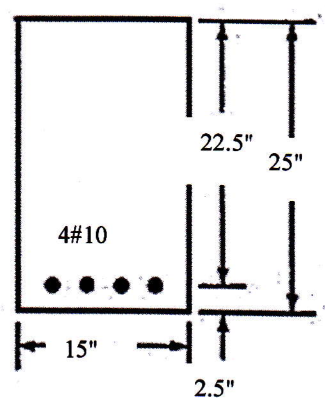
4. A rectangular beam is subjected to a moment for dead load M_D=325 k-ft and moment for live load M_L=400 k-ft. This beam of width b = 15 in. is limited by architectural considerations to a maximum total depth of h = 31 in. Use the USD method to design the flexural reinforcements for this member using compression steel if necessary. Given, f'_c = 4 ksi, f_y = 60 ksi. (10)

Part II

[Answer any **four** (04) out of following **five** (05) questions]

5.(a) Design the web reinforcement for the simply supported beam section shown in Figure 4, for which the unfactored working loads are W_D=4 k/ft and W_L=6k/ft. Given, f'_c = 4 ksi, f_y = 60 ksi. Clear span is 14 ft. (8)



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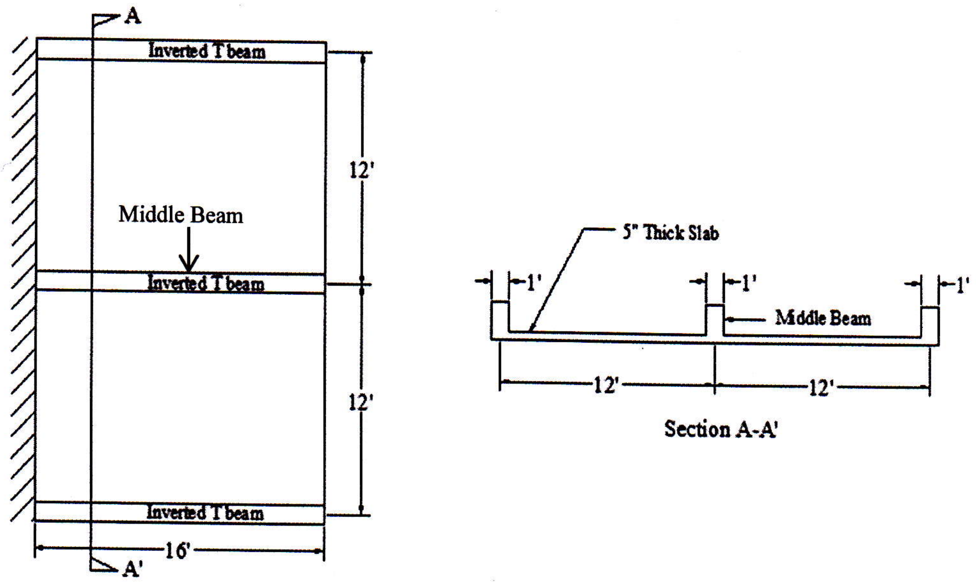
(b) Explain why the maximum shear to be considered for design is computed at a distance of 'd' from the face of the support? (2)

6. A 5" thick slab is supported by 3 inverted beams as shown in Figure 5. The slab supports a floor finish (FF) = 25 psf and a live load = 100 psf. Design the middle beam for flexure. Use the USD method. Given, $f'_c = 5$ ksi, $f_y = 60$ ksi. (10)



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7.(a) What is the minimum length of lap for column splice as per ACI code/BNBC? (2)

(b) Calculate the development length by USD method for 16 mm uncoated bar as top bar and 25 mm uncoated bar as bottom bar. Use: $f'_c = 3$ ksi, $f_y = 60$ ksi and assume appropriate value for any missing data. (3)

(c) Determine the Nominal moment capacity (M_n) of the T-beam section shown in Figure 6. Given, simply supported span of the beam= 10 ft and spacing of beam=6 ft. Use $f'_c = 3$ ksi, $f_y = 60$ ksi. (5)

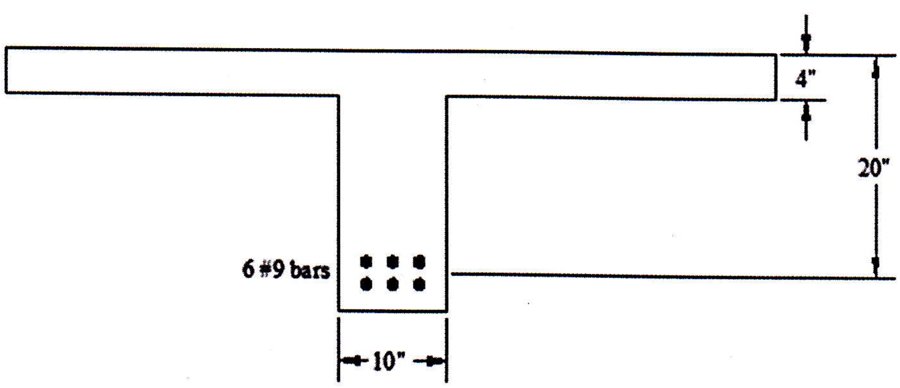
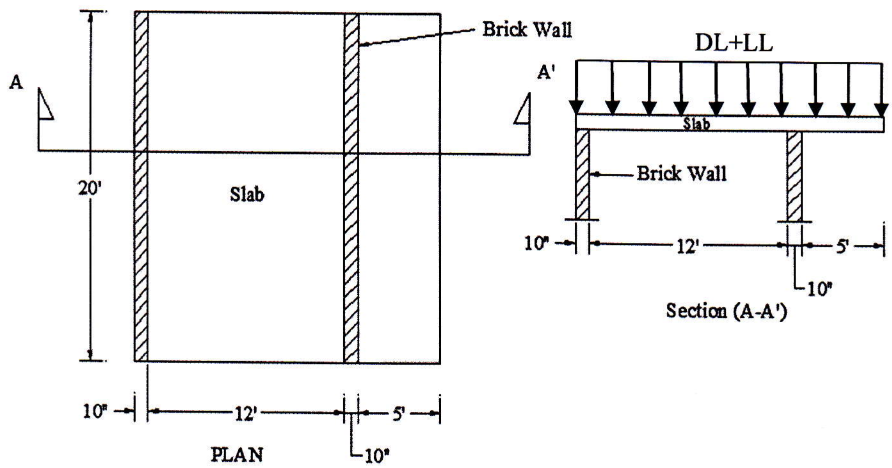


Figure 6

8. A 6 in. thick one way slab is supported by brick walls as shown in Figure 7. The slab is subjected to a calculated dead load of 125 psf and working live load of 95 psf. Compute the critical design moments in the slab and show the necessary reinforcements in sketches. Follow the USD method. Given, $f'_c = 4$ ksi, $f_y = 60$ ksi. (10)



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9.(a) Narrate the necessity of hook and anchorage for plain and deformed bars. (3)

(b) The beam of Figure 8 cantilevers from a supporting column at the left. It is adequately restrained at beam-column joint and therefore can be assumed to be fixed at the column face. If the beam carries a concentrated load P=30 kip (Unfactored), calculate the point where the center rebar can be terminated. Check to be sure that adequate embedment length is provided for both continued and discontinued bars. (5)

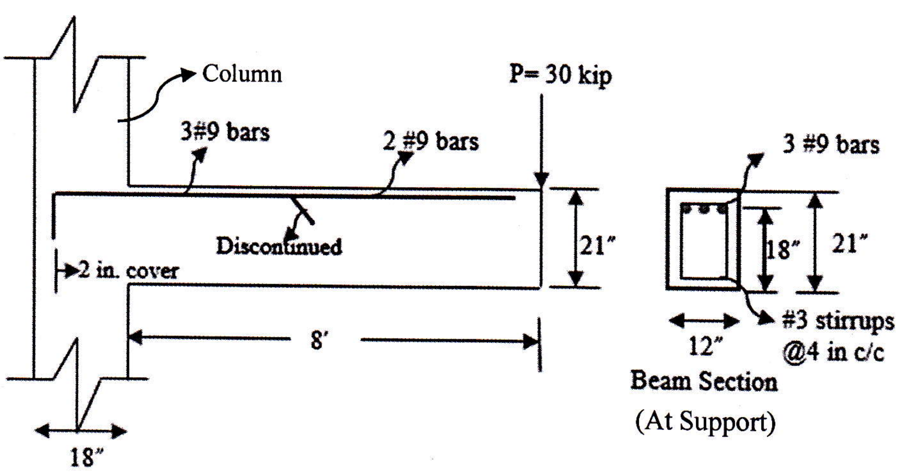

Figure 8

(c) Explain why shear reinforcements are usually not provided in the design of RC slabs. (2)

List of Useful Formulae for CE 315

Fundamentals

* Tensile strength of concrete $f_t' = 7.5\sqrt{f_c'}$ $E_s = 29 \times 10^6$ psi Modular ratio, $n = E_s/E_c$
* Within elastic limit, Flexural stress $f_c = M\ \bar{y}/\ \bar{I}$
* Steel Ratio $\rho_s = A_s/bd$ Minimum Steel Ratio $\rho_{min} = 3\sqrt{f_c'}/f_y$, often taken as $= 200/f_y$

  $Ec = 57000\sqrt{f'c}$(psi)

WSD

* 'Cracked' elastic section
  Analysis: $k = -n\rho_s + \sqrt{[2n\rho_s + (n\rho_s)^2]}$ $j = 1 - k/3$
  Design: $k = n/(n + r)$ [where $r = f_{s(all)}/f_{c(all)}$] $j = 1 - k/3$
* Singly Reinforced Beam: $M_s = A_s f_s jd$ and $M_c = (f_c kj/2)\ bd^2 = R\ bd^2$
* Balanced Stress Steel Ratio $\rho_{sb} = k/2r$, when $M_s = M_c$
* Doubly Reinforced Beam: $M_1 - Rbd^2$. $A_{s1} = M_1/(f_s jd)$

  $M_2 = M - M_1$, $A_{s2} = M_2/[f_s(d-d')]$ and $A_s' = M_2/[f_s'(d-d')]$, where $f_s' = 2f_s(k-d'/d)/(1-k)$

USD

* $\beta_1 = 0.85 - \left(\frac{f_c' - 4000}{1000}\right)(0.05) \geq 0.65$

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.005}$$

* Design conditions: $M_u < \phi M_n$, $V_u < \phi V_n$, $P_u < \phi P_n$ [$\phi = 0.483 + 83.3\varepsilon_t$]

* Singly Reinforced Analysis: $a = A_s f_y/(0.85 f_c' b)$ $M_n = A_s f_y (d - a/2) = \rho_s f_y (1 - 0.59\ \rho_s f_y/f_c')\ bd^2$

  $c = a/\beta_1$ $R_n = \frac{M_u}{\phi bd^2}$, $\rho = \frac{0.85f_c'}{f_y}\left(1 - \sqrt{1 - \frac{2R_n}{0.85f_c'}}\right)$, $A_s = \rho bd$
* Doubly Reinforced Analysis:

  $a = A_{s1} f_y/(0.85 f_c' b)$ [where $A_{s1} = A_s - A_{s2}$, and can be taken as $= A_s - A_s'$ to begin with]

  $A_{s2} = A_s' f_s'/f_y$, where $f_s' = E_s \times \varepsilon_t$

  from which A_{s1} can be revised as $= A_s - A_{s2}$ and a can also be revised accordingly

  $M_n = A_{s1} f_y (d - a/2) + A_{s2} f_y (d - d')$
* Design: Singly Reinforced if $M_n = \rho f_y (1 - 0.59\ \rho f_y/f_c')\ bd^2$

  Area Calculation: $R_n = M_u/(\phi bd^2)$, $\rho = 0.85f_c'/f_y \times [1-\sqrt{(1-2R_n/(0.85f_c'))}]$, $As = \rho bd$

  Doubly Reinforced $M_1 = M_{max}$ $A_{s1} = \rho_{max}\ bd$,

  $M_2 = M_n - M_1$ $A_{s2} = M_2 / f_y (d - d')$

  Determination of c: $A_s f_y = 0.85 f_c' \beta_1 cb + E_s \epsilon_u A_s'(c-d')/c$; Check ϕMn: $\phi Mn = A_{s1} f_y(d-a/2) + A_s' f_s(d-d') > M_u$
* T-beam b_{eff} is the minimum of L/4, $(16t + b_w)$, and (c/c distance between adjacent beams)

  L-beam b_{eff} is the minimum of $(L/12 + b_w)$, $(6t + b_w)$, and (b_w + half the clear distance between adjacent beams)
* USD Analysis $M_n = A_s f_y(d-a/2)$, if $a \leq h_f$

  $M_n = A_s f_y(d-\bar{y})$, if $a > h_f$

Or,

* USD Analysis: $A_{sf} = 0.85 f_c' (b_{eff} - b_w)t / f_y$ $M_{nf} = A_{sf} f_y (d - t/2)$

  $A_{sw} = A_s - A_{sf}$ $a = A_{sw} f_y/(0.85 f_c' b_w)$ $M_{nw} = A_{sw} f_y (d - a/2)$ $\boxed{M_n = M_{nf} + M_{nw}}$

  Design: $A_{sf} = 0.85 f_c' (b_{eff} - b_w)t / f_y$, $M_{uf} = A_{sf} f_y (d - t/2)$; while A_{sw} can be obtained from $M_{uw} = M_u - M_{uf}$

Parameters of Development Length of Tension Bars

Symbol	Parameter	Variable	Value
α	Reinforcement Location Factor	• Horizontal Reinforcement over ≥ 12" concrete • Other Reinforcement	1.3 1.0
β	Coating Factor	• Epoxy-coated bars with cover $<3d_b$ or clear spacing $<6d_b$ • All other epoxy-coated bars or wires • Uncoated bars • Maximum value of $\alpha\beta$	1.5 1.2 1.0 1.7
γ	Reinforcement Size Factor	• ≥ #7 bars • ≤ #6 bars and deformed wires	1.0 0.8 (?)
λ	Lightweight Aggregate Concrete Factor	• When lightweight aggregate concrete is used • When normal-weight concrete is used	1.3 1.0
c	Spacing or Cover Dimension (in)	• Bar center to nearest concrete cover • One-half the c/c spacing of bars	Smaller than both
K_{tr}	Transverse Reinforcement Index	S = Maximum spacing of transverse reinforcement A_{tr} = Area of all transverse reinforcement within S f_{tr} = Yield strength of transverse reinforcement, ksi n = No. of bars being developed along the plane of splitting	$A_{tr} f_{tr}/(1.5Sn)$

$$l_d/d_b = (3/40)\,(f_y/\sqrt{f_c'})\,(\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$$

where the term $(c + K_{tr})/d_b$ is ≤ 2.5.

Simplified Equations for Basic Development Length (Tension)

Condition	$(c + K_{tr})/d_b$	l_d
Avoid pullout failure (Experimentally derived limit)	2.5	$0.03\,(f_y/\sqrt{f_c'})d_b$
* Clear cover and Clear spacing $\ge d_b$ + Code required stirrups * Clear cover and Clear spacing $\ge 2d_b$	1.5	$0.05\,(f_y/\sqrt{f_c'})d_b$ (≥ #7 Bars) $0.04\,(f_y/\sqrt{f_c'})d_b$ (≤ #6 Bars and deformed wires) (?)

Bar Diameter and area

d (No.)	2	3	4	5	6	7	8	9	10
A_s (in²)	0.05	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27

d (mm)	8	10	12	16	19	22	25	28	31
A_s (in²)	0.08	0.12	0.18	0.31	0.44	0.59	0.76	0.95	1.17

Shear Design

* $S = A_v f_v d/(V_{cu} - V_{c}) = A_v f_v/\{(v_{cu} - v_c)\,b\}$ for vertical stirrups, and

$S = A_v f_v d\,(\sin\alpha + \cos\alpha)/(V_{cu} - V_c) = A_v f_v(\sin\alpha + \cos\alpha)/\{(v_{cu} - v_c)\,b\}$ for inclined stirrups

Summary of ACI Shear Design Provisions (Vertical Stirrups)

	USD	Additional Provisions
Design Shear Force	$V_n = V_u/\phi$ [$\phi = 0.75$]	Calculated at d from Support face
Min^m Section Depth	$V_n/8\sqrt{f_c'}b_w$	$f_y \le 60$ ksi
Allowable Concrete Shear, V_C	$2\sqrt{f_c'}\,bd$	$\sqrt{f_c'} \le 100$ psi $Vd/M \le 1.0$
No Stirrup	$V_u \le \phi V_c/2$	
Max^m Spacing	d/2, 24" $S = A_v f_y/50b_w$	To be halved if $V_s \ge 4\sqrt{f_c'}b_w d$ OR $V_w \ge 2\sqrt{f_c'}b_w d$ in WSD

Slabs with f_y = 40 or 50 ksi	0.0020	**Temperature and shrinkage reinforcement**
Slabs with $f_y \ge 60$ ksi	$0.0018 \times (60/f_y) \ge 0.0014$	

Simply Supported	One end continuous	Both ends continuous	Cantilever	**Minimum Thickness of One way Slab**
L/20	L/24	L/28	L/10	

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B. Sc. Engineering (Civil)

Course Title: Design of Concrete Structures I
Time: 3 hours

Course Code: CE 315
Full Marks: 70 (= 7× 10)

[Assume reasonable values for missing data]

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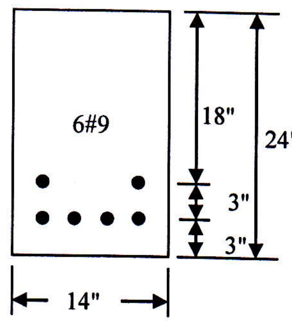

Figure 1

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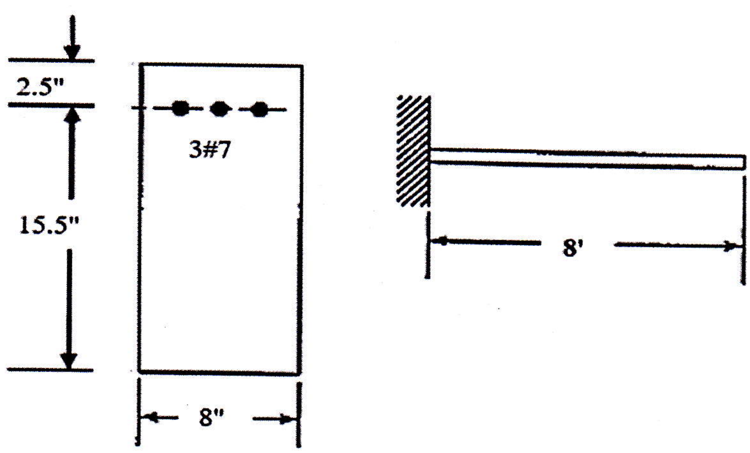

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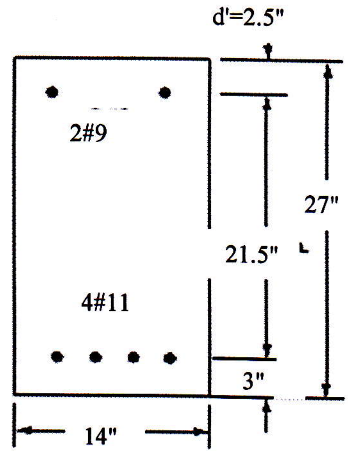

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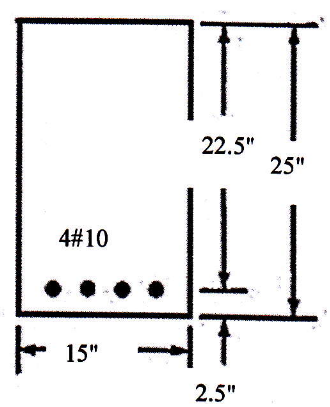

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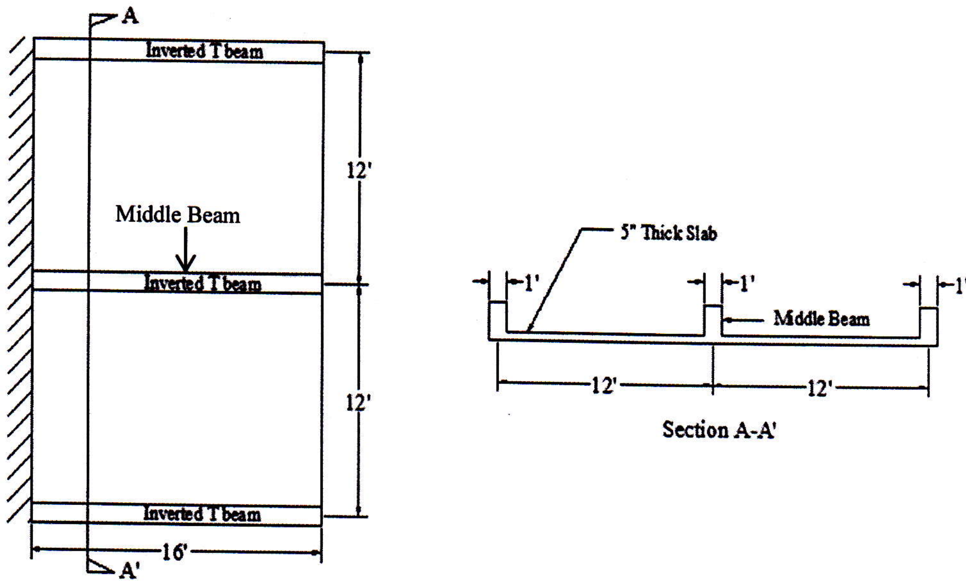

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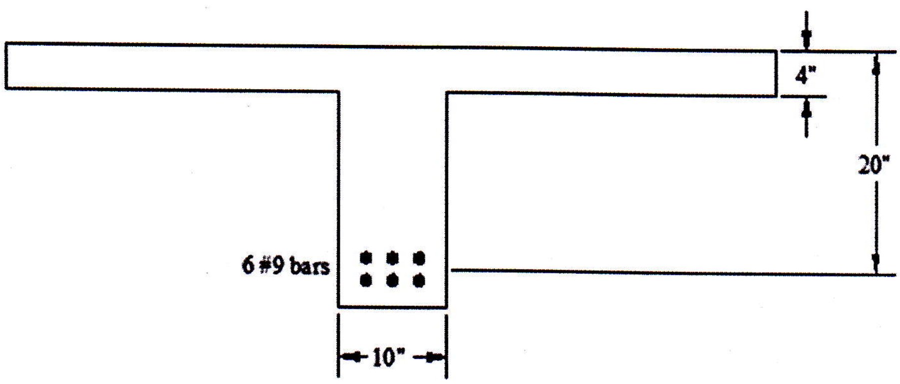

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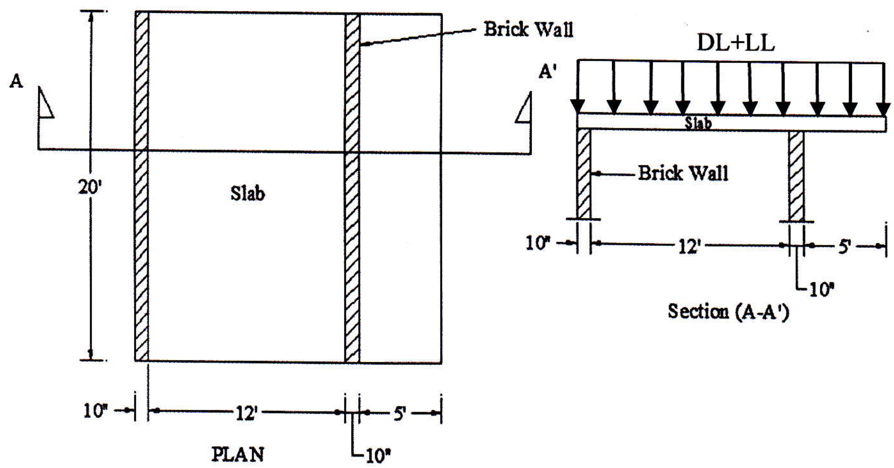

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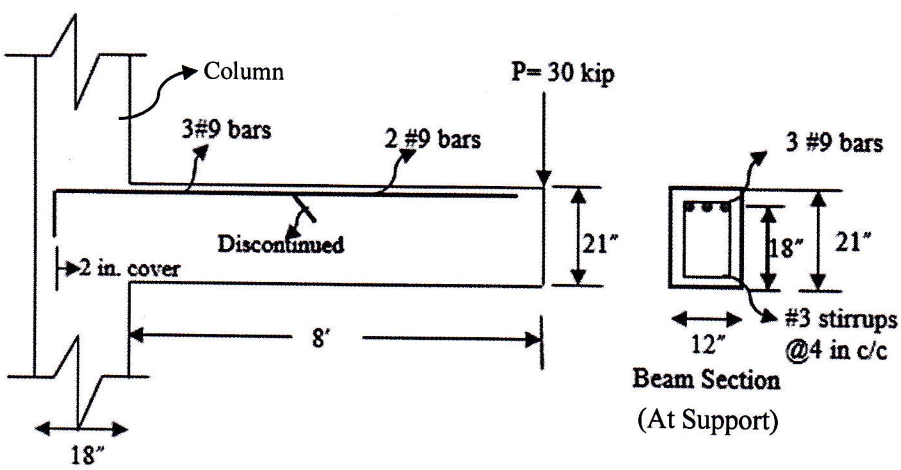

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Design: $k = n/(n + r)$ [where $r = f_{s(all)}/f_{c(all)}$] $j = 1 - k/3$

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$M_2 = M - M_1$, $A_{s2} = M_2/[f_s(d-d')]$ and $A_s' = M_2/[f_s'(d-d')]$, where $f_s' = 2f_s(k\ \ d'/d)/(1-k)$

USD

* $\beta_1 = 0.85 - \left(\frac{f_c' - 4000}{1000}\right)(0.05) \geq 0.65$

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.005}$$

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* Doubly Reinforced Analysis:

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from which A_{s1} can be revised as $= A_s - A_{s2}$ and a can also be revised accordingly

$M_n = A_{s1} f_y (d - a/2) + A_{s2} f_y (d - d')$

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Area Calculation: $R_n = M_u/(\phi bd^2)$, $\rho = 0.85f_c'/f_y \times [1-\sqrt{(1-2R_n/(0.85f_c'))}]$, $As = \rho bd$

Doubly Reinforced $M_1 = M_{max}$ $A_{s1} = \rho_{max}\ bd$,

$M_2 = M_n - M_1$ $A_{s2} = M_2 / f_y (d - d')$

Determination of c: $A_s f_y = 0.85 f_c' \beta_1 cb + E_s \epsilon_u A_s'(c-d')/c$; Check ϕMn: $\phi Mn = A_{s1} f_y(d-a/2) + A_s' f_s(d-d') > M_u$

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L-beam b_{eff} is the minimum of $(L/12 + b_w)$, $(6t + b_w)$, and (b_w + half the clear distance between adjacent beams)

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Or,

* USD Analysis: $A_{sf} = 0.85 f_c' (b_{eff} - b_w)t / f_y$ $M_{nf} = A_{sf} f_y (d - t/2)$

$A_{sw} = A_s - A_{sf}$ $a = A_{sw} f_y/(0.85 f_c' b_w)$ $M_{nw} = A_{sw} f_y (d - a/2)$ $\boxed{M_n = M_{nf} + M_{nw}}$

Design: $A_{sf} = 0.85 f_c' (b_{eff} - b_w)t / f_y$, $M_{nf} = A_{sf} f_y (d - t/2)$; while A_{sw} can be obtained from $M_{nw} = M_n - M_{nf}$

Parameters of Development Length of Tension Bars

Symbol	Parameter	Variable	Value
α	Reinforcement Location Factor	• Horizontal Reinforcement over ≥ 12" concrete • Other Reinforcement	1.3 1.0
β	Coating Factor	• Epoxy-coated bars with cover <$3d_b$ or clear spacing <$6d_b$ • All other epoxy-coated bars or wires • Uncoated bars • Maximum value of $\alpha\beta$	1.5 1.2 1.0 1.7
γ	Reinforcement Size Factor	• ≥ #7 bars • ≤ #6 bars and deformed wires	1.0 0.8 (?)
λ	Lightweight Aggregate Concrete Factor	• When lightweight aggregate concrete is used • When normal-weight concrete is used	1.3 1.0
c	Spacing or Cover Dimension (in)	• Bar center to nearest concrete cover • One-half the c/c spacing of bars	Smaller than both
K_{tr}	Transverse Reinforcement Index	S = Maximum spacing of transverse reinforcement A_{tr} = Area of all transverse reinforcement within S f_{tr} = Yield strength of transverse reinforcement, ksi n = No. of bars being developed along the plane of splitting	$A_{tr} f_{tr}/(1.5Sn)$

$$l_d/d_b = (3/40)\ (f_y/\sqrt{f_c'})\ (\alpha\beta\gamma\lambda)/\{(c + K_{tr})/d_b\}$$

where the term $(c + K_{tr})/d_b$ is ≤ 2.5.

Simplified Equations for <u>Basic</u> Development Length (Tension)

Condition	$(c + K_{tr})/d_b$	l_d
Avoid pullout failure (Experimentally derived limit)	2.5	$0.03\ (f_y/\sqrt{f_c'})d_b$
* Clear cover and Clear spacing ≥ d_b + Code required stirrups * Clear cover and Clear spacing ≥ $2d_b$	1.5	$0.05\ (f_y/\sqrt{f_c'})d_b$ (≥ #7 Bars) $0.04\ (f_y/\sqrt{f_c'})d_b$ (≤ #6 Bars and deformed wires) (?)

<u>Bar Diameter and area</u>

d (No.)	2	3	4	5	6	7	8	9	10
A_s (in^2)	0.05	0.11	0.20	0.31	0.44	0.60	0.79	1.00	1.27
d (mm)	8	10	12	16	19	22	25	28	31
A_s (in^2)	0.08	0.12	0.18	0.31	0.44	0.59	0.76	0.95	1.17

<u>Shear Design</u>

• $S = A_v f_v d/(V_{ext} - V_c) = A_v f_v/\{(v_{ext} - v_c)\ b\}$ for vertical stirrups, and

$S = A_v f_v d\ (\sin\alpha + \cos\alpha)/(V_{ext} - V_c) = A_v f_v (\sin\alpha + \cos\alpha)/\{(v_{ext} - v_c)\ b\}$ for inclined stirrups

Summary of ACI Shear Design Provisions (Vertical Stirrups)

	USD	Additional Provisions
Design Shear Force	$V_n = V_u/\phi$ [ϕ = 0.75]	Calculated at d from Support face
Min^m Section Depth	$V_u/8\sqrt{f_c'}b_w$	$f_y \le 60$ ksi
Allowable Concrete Shear, V_C	$2\sqrt{f_c'}\ bd$	$\sqrt{f_c'} \le 100$ psi $Vd/M \le 1.0$
No Stirrup	$V_u \le \phi V_c/2$	
Max^m Spacing	d/2, 24" $S = A_v f_y/50b_w$	To be halved if $V_s \ge 4\sqrt{f_c'}b_w d$ OR $V_w \ge 2\sqrt{f_c'}b_w d$ in WSD

Slabs with f_y = 40 or 50 ksi	0.0020	**Temperature and shrinkage reinforcement**
Slabs with f_y ≥ 60 ksi	$0.0018 \times (60/f_y) \ge 0.0014$	

Simply Supported	One end continuous	Both ends continuous	Cantilever	
L/20	L/24	L/28	L/10	**Minimum Thickness of One way Slab**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering I — Course No: CE 331
Time: 3.0 hours — Full Marks: 100

There are six (6) questions. Question no. 6 is compulsory. Answer question no. 6 and any four (4) from the rest (20 + 20×4=100). Assume any missing data.

1. (a) What is per capita demand? Enlist the factors affecting the water demand of an area. Explain the methods for limiting the water consumption of a community. [2+2+6]

   (b) With a schematic diagram show the role of water in sustainable development. [5]

   (c) Predict the population for the year 2021 and 2041 from the following population data: [5]

Year	1971	1981	1991	2001	2011
Population	7	10	12	13	16

2. (a) Derive the equation of well discharge for an unconfined aquifer. A 100mm diameter tube well is sunk to withdraw water from a 10 m thick confined aquifer having K=0.75 lps/m^2. The drawdown is 2m in the tube well while pumping. Calculate the tube well discharge when radius of circle of influence is 30 m. [7+3]

   (b) Explain "Sustainable Water Management". With a schematic diagram show the elements of sustainable water management. [3+2]

   (c) Write a short note on rainwater harvesting system as an alternative water supply option. [5]

3. (a) Construction of a piped water supply scheme is proposed in a rural area which is affected by mostly arsenic and salinity. What considerations are needed to accomplish the scheme successfully? [15]

   (b) Design a suitable set of pumping unit to deliver 500,000 gph from an intake well of a river bank to the treatment plant. Total length of rising main from the intake well to the treatment plant is 1000 ft and the static head is 60 ft. Assume: Velocity of water = 15 fps; Friction factor = 0.0075; Pump efficiency = 70%. [5]

4. (a) The following criteria are used in the design example: [10]

   i. Flow rates:
   - Maximum flow rate=114,000m^3/d
   - Average flow rate=60,000m^3/d

   ii. Raw water quality:
   - Turbidity: 3-17 NTU
   - Seasonal Fe and Mn concentration: 0.2-0.7 mg/L and 0.05-0.4 mg/L

- pH= 7.9-8.2
- Total alkalinity: 80-110mg/L as $CaCO_3$
- Total hardness: 100-120mg/L as $CaCO_3$
- Width of sedimentation basin 20.0 m

iii. Chemicals:
- Coagulant: ferric sulfate, optimum dosage 25mg/L, maximum feed rate 60 mg/L. Application point is rapid mix basin.
- pH adjustment: $Ca(OH)_2$ is required to adjust pH 8 to 9 units. 15 mg/L of $Ca(OH)_2$ is sufficient to provide optimum pH.
- $KMnO_4$: Needed for Fe, Mn precipitation.

iv. Rapid Mix basin design parameters:
- Number of units= 4 basin
- Detention time = 20-30s
- G = 950/s

v. Flocculation basin design parameters:
- Number of basins=4
- Number of stages=3
- Detention time =30min total, 10min in each stage
- G=60/s

Calculate: (i) basin volume for rapid mixing; (ii) power requirement for rapid mixer; (iii) dimensions of flocculation basin; (iv) chemical requirements.

(b) Explain typical settling types of suspended particles in sedimentation tanks. What is the mechanism of pressure filters when employed for water treatment? [2+3]

(c) With schematic diagrams describe different types of water transmission and distribution systems. [5]

5. (a) With a flow diagram show different mechanisms of arsenic removal from groundwater. What is the main difference between diffusion and mechanical aerators in a treatment plant? [10]

(b) Write short notes on: (i) floating intake; and (ii) submerged intake. [2.5+2.5]

(c) What are the causes and preventive approaches of water hammer in water distribution networks? [5]

6. (a) Propose treatment flow diagrams for raw water sources (W_1, W_2) having characteristics shown in the following table and also explain the steps of the flow diagrams. The index shown in the parenthesis of the parameter represents Bangladesh Standard (BS) value of that parameter. The following table also shows comparison of the parameter values (of corresponding sources) with BS so that it can be easily identified which parameters require treatment. '√' represents the parameter is within the limit of BS and 'X' represents the parameter is beyond the limit of BS and requires treatment. [20]

Parameter	Unit	W_1		W_2	
		Value	Check with BS	Value	Check with BS
pH	--	6.3		6.6	
Turbidity (25)	NTU	30.0	X	4.0	√
Color (30)	TCU	1.0	√	38.0	X
CO_2 (15)	mg/L	95.0	X	10.0	√
Alkalinity, A	mg/L	58.0	A<H	160.0	A>H
Hardness, H	mg/L as $CaCO_3$	400.0		75.0	
Fe (1)	mg/L	5.0	X	0.9	√
Mn (0.1)	mg/L	2.0	X	0.08	√
As (0.05)	mg/L	0.03	√	0.07	X
BOD_5 (10)	mg/L	40.0	X	8.0	√

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2017
Program: B. Sc. Engineering (Civil)

Course Title: Open Channel Flow — Course Code: CE 361

Time: 3 hours — Full marks: 150

Answer all the questions in both of the sections. (25*6= 150)
(Assume reasonable data)

SECTION – A

1 (a) Sketch the definition diagram of hydraulic jump showing all its features. (5)

(b) Describe the conditions for uniform flow and gradually varied flow. (5)

(c) Water flows at a velocity of 6.1 m/s and a depth of 1m in a 6.1 m wide horizontal rectangular channel. Find: (15)

i) the downstream depth necessary to form a hydraulic jump,
ii) the type of jump,
iii) the height of the jump,
iv) the length of the jump,
v) the horsepower dissipation in the jump, and
vi) the efficiency of the jump

2 (a) Predict the possible flow profiles in the following serial arrangement of channels or conditions and provide sketch. The flow is from left to right: (8)

(i) Mild-milder-steep, (ii) Critical-steep-mild, (iii) Mild-steeper mild, (iv) At varying water levels downstream of a mild slope channel

(b) Explain the behavior of flow profiles when i) $h \rightarrow h_n$, ii) $h \rightarrow h_c$ and iii) $h \rightarrow 0$ (5)

(c) A wide rectangular channel with $C = 45\ m^{1/2}/s$ and $S_0 = 0.0001$ carries a discharge of 1.8 m^2/s. A weir causes the water level to be raised by 0.50 m above the normal depth. Compute the length of the resulting flow profile between the weir site and the location where the depth is 2.8 m by the Bresse method. (drawing required) (12)

OR

(a) Predict the possible flow profiles in the following serial arrangement of channels or conditions and provide sketch. The flow is from left to right: (8)

(i) Mild-steep, (ii) Steep-mild-steeper mild, (iii) Upstream an downstream of a sluice gate in a steep slope channel, (iv) Mild-steeper mild-steep

(b) Following the procedure for deriving qualitative flow profiles, show the procedure and draw the profiles: M2 and S1. (5)

(c) A trapezoidal channel with b = 6m an s = 2 is laid on a slope of 0.0025 and carries a discharge of 30 m^3/s. The depth produced by a dam immediately upstream of it is 2.5 m. Compute the resulting flow profile. Take $\alpha = 1.12$ and n = 0.025. [use $h_n = 1.6$ m and $h_c = 1.33$ m] (12)

3(a) Derive Horton's Formula for composite roughness **OR** derive the ratio between the bottom shear and side shear stresses in a trapezoidal channel. (8)

(b) Differentiate between "minimum permissible velocity" and "non-erodible velocity". (4)

(c) A lined channel (n = 0.015) is to be laid on a slope of 1 in 2000. The side slope of the channel is to be maintained at 1.5:1. i) Determine the depth of flow of a triangular section with rounded corner to carry a discharge of 40 m^3/s. ii) Determine the dimensions of a trapezoidal section with rounded corners to carry a discharge of 80 m^3/s when the maximum permissible velocity is 2 m/s. (13)

OR

By using Lacey's method, design a stable alluvial channel when d= 0.13 cm and the discharge is 20 m^3/s.

SECTION – B

4 (a) Define "transition". Illustrate two control sections with explanations. (2+6)

(b) Verify that "at the critical state of flow, the discharge is maximum" (5)

OR

Verify that "at the critical state of flow, the specific energy is minimum for a given discharge".

(c) Water is flowing at a velocity of 2 m/s and a depth of 2.5 m in a long rectangular channel 6 m wide. Calculate the height of a smooth upward step in the channel bed to produce critical flow. Also evaluate the change in water level produced by the step. Neglect energy losses and take α=1. (12)

OR

A rectangular channel has bottom width of 6m, α= 1 and n = 0.025. i) Calculate the normal slope at a normal depth of 1m when the discharge is 20 m^3/s and ii) Calculate the critical slope when the discharge is 20 m^3/s.

5 (a) Classify open channel flow. Define Reynolds number and Froude number. (3+4)

(b) Describe the velocity distribution coefficients. Provide the expressions for computing the coefficients and explain why these coefficients are used in open channel flow. (7)

OR

Discuss the expression for the pressure distribution in curvilinear flow using a figure.

(c) Water flows in an open channel at a depth of 1m and a mean velocity of 3 m/s. Compute the discharge an determine the state of flow if the channel is circular whose diameter is 2.5 m. (11)

OR

In a wide river the velocity varies along a vertical as u = 1+2z/h, where h is the total depth and u is the total velocity at a distane z from the channel bottom. The river is 5 m deep; i) determine the state of flow and ii) compute the numerical values of the velocity distribution coefficients α and β.

6 (a) State the principles that the continuity, energy and momentum equations are based on respectively. (6)

(b) Classify hydraulic jump explaining the conditions and features of each type of jump (no figure required). (6)

OR

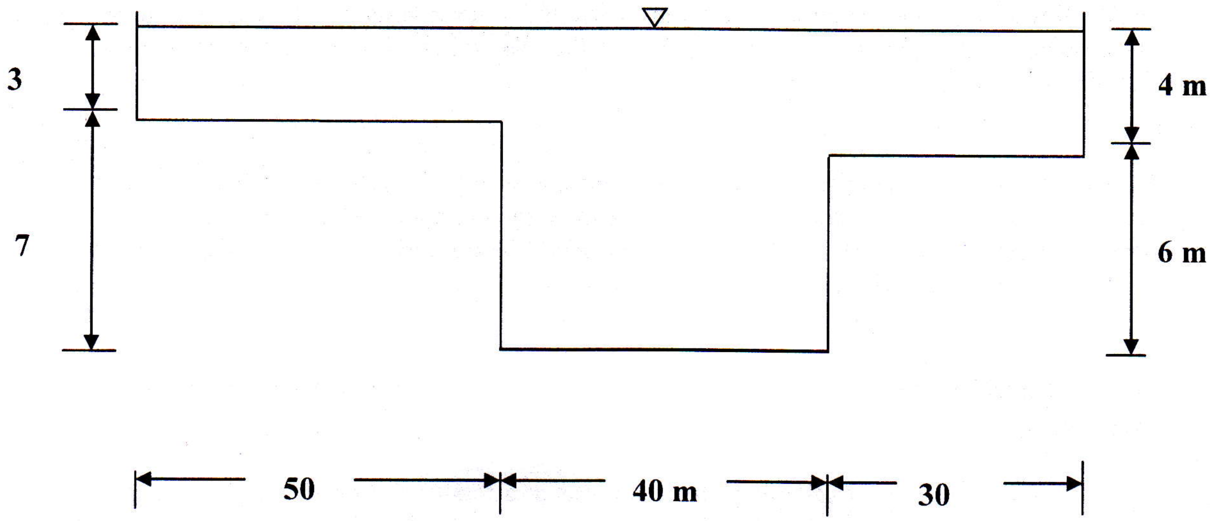
Indicate the practical applications of each type of profiles that are generated in the mild and steep slope channels.

(c) Analyze the flood discharge through a river reach 1000 m long having a fall in water surface of 0.85 m (using slope-area method). Neglect the eddy loss. Use the following data: (13)

Section	A (m^2)	P (m)	n	α
Upstream	12,000	2,150	0.03	1.15
Downstream	10,500	2,050	0.03	1.18

OR

A channel consists of a main section and two side sections as shown in the following figure. Calculate the total discharge, the mean velocity of flow and the Manning's n for the entire section when n = 0.025 for the main channel, n = 0.045 for the side channels and S_o= 0.0002. Also compute the numerical values of α and β for the entire section assuming that α = β = 1.00 for the main channels and the side sections.



Given Formulae

$\bar{U} = \dfrac{\int_0^A u\,dA}{A}$ $\alpha = \dfrac{\int_0^A u^3\,dA}{\bar{U}^3 A}$ $\beta = \dfrac{\int_0^A u^2\,dA}{\bar{U}^2 A}$	Trapezoidal channel $A = (b + sh)h$ $P = b + 2h\sqrt{1 + s^2}$ $B = b + 2sh$	Circular Channel $h = \dfrac{d_o}{2}\left[1 - cos\dfrac{\omega}{2}\right]$ $\omega = 2cos^{-1}\left(1 - \dfrac{2h}{d_o}\right)$ $A = (\omega - sin\omega)\dfrac{d_o^2}{8}$ $B = d_o \sin\dfrac{\omega}{2}$ $P = \dfrac{\omega d_o}{2}$ *Note that ω is in radian*

Type equation here.

Channels with rounded corners:

Triangular: $A = h^2 (\varphi + \cot\varphi)$; $P = 2h (\varphi + \cot\varphi)$

Rectangular: $A = bh + h^2 (\varphi + \cot\varphi)$; $P = b + 2h (\varphi + \cot\varphi)$

Bresse function:

$$\emptyset = \frac{1}{6}\ln\frac{u^2+u+1}{(u-1)^2} - \frac{1}{\sqrt{3}}tan^{-1}\frac{\sqrt{3}}{2u+1}$$

Where $u = h/h_n$

$$L = x_2 - x_1 = \frac{h_n}{S_0}\left[(u_2 - u_1) - \left(1 - \frac{h_c^3}{h_n^3}\right)(\Phi_2 - \Phi_1)\right]$$

$$\alpha = \frac{\alpha_1 K_1^3/A_1^2 + \alpha_2 K_2^3/A_2^2 + \alpha_3 K_3^3/A_3^2}{K^3/A^2}$$

$$\beta = \frac{\beta_1 K_1^2/A_1 + \beta_2 K_2^2/A_2 + \beta_3 K_3^2/A_3}{K^2/A}$$

$$n = \left(\frac{P_1 n_1^{3/2} + P_2 n_2^{3/2} + P_3 n_3^{3/2}}{P}\right)^{2/3}$$

Lane Method: $\tau_b = 0.40\, d_{75}$

$$K = \frac{\tau_s}{\tau_b} = \sqrt{1 - \frac{sin^2\phi}{sin^2\Psi}}$$

Rectangular channel: $h_c = \sqrt[3]{\frac{\alpha Q^2}{gb^2}}$; $S_c = \left(\frac{nQ}{AR^{2/3}}\right)^2$

$Fr = U/\sqrt{(gD)}$; $Q = K\sqrt{S_f}$; $K = AR^{2/3}/n$

$h_f = F + (\alpha_1 U_1^2/2g - \alpha_2 U_2^2/2g\_ - h_e$

$\Delta x = E_2\text{-}E_1/(S_0 - S_f\text{bar})$

For Hydraulic Jump:

$$\frac{h_2}{h_1} = \frac{1}{2}\left(\sqrt{1 + 8F_{r1}^2} - 1\right)$$

$$h_L = \frac{(h_2 - h_1)^3}{4h_1 h_2}$$

$$\frac{E_2}{E_1} = \frac{(1 + 8F_{r1}^2)^{3/2} - 4F_{r1}^2 + 1}{8F_{r1}^2(2 + F_{r1}^2)}$$

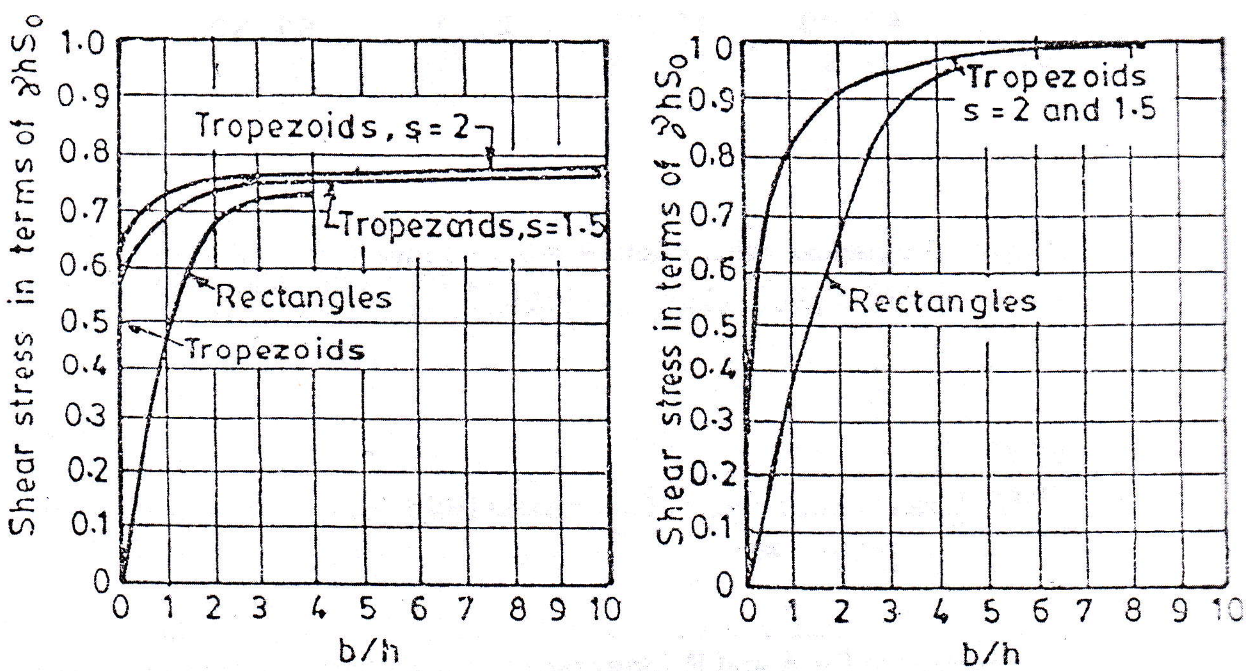
$$\frac{h_j}{E_1} = \frac{\sqrt{1 + 8F_{r1}^2} - 3}{2 + F_{r1}^2}$$

$$L_j = 9.75 h_1 (F_{r1} - 1)^{1.01}$$

$$F_2 = \frac{Q^2}{gA_2} + \bar{z}_2 A_2$$

For trapezoidal channel, $\bar{z} = \frac{h}{6}\left(\frac{3b+2sh}{b+sh}\right)$

Maximum Shear Stress on (a) sides and (b) bottom of channel



(a) (b)