3-1

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: B.Sc. in Civil Engineering

Course Title: Principles of Accounting — Course Code: ACN 301
Time: 2 hours — Credit Hour: 2 — Full Marks: 50

Submit your question inside your answer script

(5*3=15)

1. Answer any three of the following questions:

i. Briefly explain the importance of ratio analysis with examples.
ii. "All steps of accounting cycle are linked with each other"- Explain.
iii. Define is adjusting entry? Briefly differentiate product cost and period cost.
iv. Briefly differentiate temporary accounts and permanent accounts.

(20)

2. Data for Iftekhar Corporation are shown below:

	Total	Per unit
Sales	Tk. 500,000	Tk 100
(-) Variable expense	300,000	(60)
Contribution margin	200,000	Tk 40

Fixed expenses are Tk 70,000 per month and the company is selling 5,000 units per month.

i. Calculate contribution margin ratio. (1)
ii. Calculate net operating income of above information. (1)
iii. Calculate the company's break-even point in unit sales. (1)
iv. Calculate the company's break-even point in Tk sales. (1)
v. If the company's fixed expenses increase by Tk 10,000, calculate the new break-even point in unit sales? In Taka sales? (2)
vi. Calculate the unit sales needed to attain a target profit of Tk 40,000. (1)
vii. Calculate the Taka sales needed to attain a target profit of Tk 55,000. (1)
viii. Refer to the original data, calculate the revised net operating income if the selling price per unit increases by 10%, variable expenses increase by 0.80 cents per unit, and the number of units sold decreases by 10%? (4)
ix. Refer to the original data, how much will net operating income increase (decrease) per month if the monthly rent expense increases by Tk 5,000 and the monthly sales volume increases by 100 units? (4)
x. Refer to the original data, how much will net operating income increase (decrease) per month if the company uses higher-quality components that increase the variable expense by Tk 1.50 per unit, increase unit sales by 10% and decrease fixed expense by Tk 5,000. (4)

(15)

3. Answer any one of the followings (a or b):

a. The comparative statements of Jupiter Company are presented below:

Jupitar Company
Balance sheet

	2020(Taka)	2019(Taka)	2018 (Taka)
Assets:			
Current assets			
Cash	21,000	18,000	20,000
Short- term investments	18,000	15,000	14,000
Accounts receivables (net)	86,000	74,000	70,000
Inventory	90,000	70,000	100,000
Total Current Assets	215,000	177,000	204,000
Fixed Assets	423,000	383,000	346,000

Total Assets	**Tk 638,000**	**Tk. 560,000**	**Tk 550,000**
Liabilities and Stockholder's Equity:			
Current liabilities			
Accounts payable	122,000	110,000	100,000
Income tax payable	23,000	22,000	20,000
Total Current Liabilities	145,000	130,000	120,000
Long term liabilities			
Bond payable	120,000	80,000	100,000
Total Liabilities	265,000	210,000	220,000
Stockholders' equity			
Common stock (Tk 5 par)	150,000	150,000	150,000
Retained earnings	223,000	200,000	180000
Total stockholders' equity	373,000	350,000	330,000
Total Liabilities & Stockholders' Equity	**Tk 638,000**	**Tk 560,000**	**Tk 550,000**

Other Information:

	2020 (Taka)	2019 (Taka)	2018 (Taka)
Net Sales	600,000	520,000	550,000
Cost of Goods Sold	415,000	354,000	300,000
Net Income	38,400	31,400	35,000

Required: Compute the following ratios of 2020 and 2019 and compare the results of two years:

i. Current ratio
ii. Inventory turnover
iii. Profit margin
iv. Asset turnover
v. Debt to asset ratio

Or

b. Some of the beginning balances of Moon Company of its trial balance on July 01, 2023:

	Debit (tk)	Credit (tk)
Cash	60,000	
Supplies	2,800	
Equipment	25,000	
Unearned rent revenue		10,200
Service revenue		60,000
Interest expense	1000	
Salaries and wages expense	14,000	

i. Prepare the journal entries of Moon Company:

July 01. Moon company invested cash in business Tk 500,000.
July 12. Paid one-year insurance policy Tk 3,600.
July 13. Cash received Tk. 10,200 but service has not yet been performed.
July 15. Purchase equipment Tk 20,000.
July 31. Salaries are paid Tk. 20,000 of which Tk 15,000 is paid for current monrth.

ii. Prepare the adjusting entries of Moon Company:

1. The equipment depreciates Taka 400 per month.
2. One-third of total unearned rent revenue was earned during the quarter.
3. Supplies on hand total Taka 900.
4. Insurance expires at the rate of Taka 200 per month.
5. Accrued utility expense Taka 1,000.
6. Service performed Tk 15,000 but cash has not received yet.

iii. Prepare cash and unearned service revenue ledger.

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: B.Sc. in Civil Engineering

Course Title: Structural Engineering I — Course Code: CE 311

Time: 3 hours — Credit Hour: 3.0 — Full Marks: 100

ANSWER ALL QUESTIONS. Assume any missing data reasonably.

PART-A

1. Analyze the truss shown in ***Fig.1***, to **[15]**
   a) Calculate the maximum reaction at support *a*,
   b) Calculate the maximum compression and tension forces in members *hi* and *hc*,
   The truss bridge is subjected to 20 kip concentrated live load moving across the stringers.

   [Note: Stringers are simply supported on floor-beams at top-cord joints].

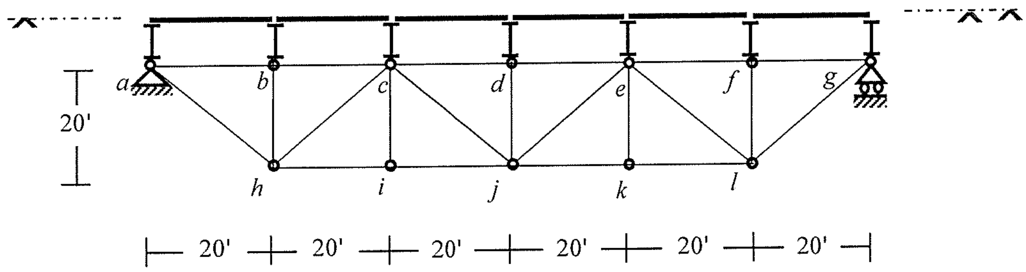


Fig.1: Truss Bridge

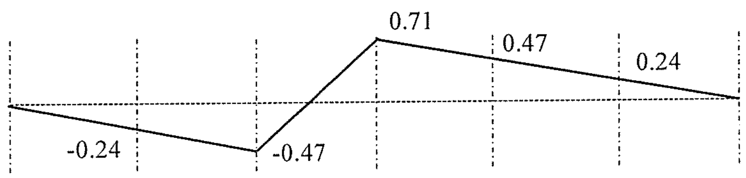


Fig.2: Influence line of force in member *cj*

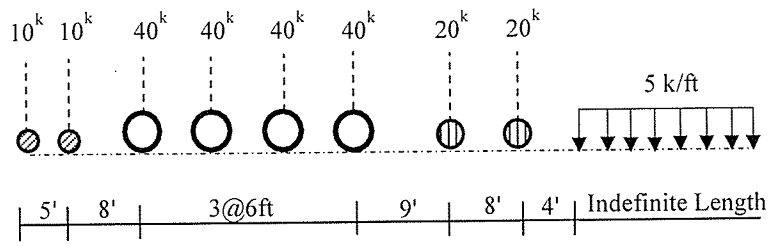


Fig.3: Wheel load arrangement

2. Analyze the truss shown in ***Fig.1***, to obtain the maximum force in member *cj*. The truss is subjected to wheel loads shown in ***Fig.3*** moving from right to left across the bridge. **[15]**

3. Analyze the plate girder shown in ***Fig.4***, to obtain the maximum values of floor beam reaction at A (FBR_A), R_C, $V_{D(R)}$ and M_D if a unit load passes over the stringers.

[10]

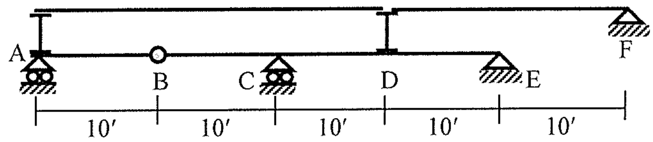


Fig.4

4. For the wheel load arrangement shown in ***Fig.5*** **[10]**
   a) Calculate the maximum shear at *C*
   b) Calculate the maximum moment at *C*

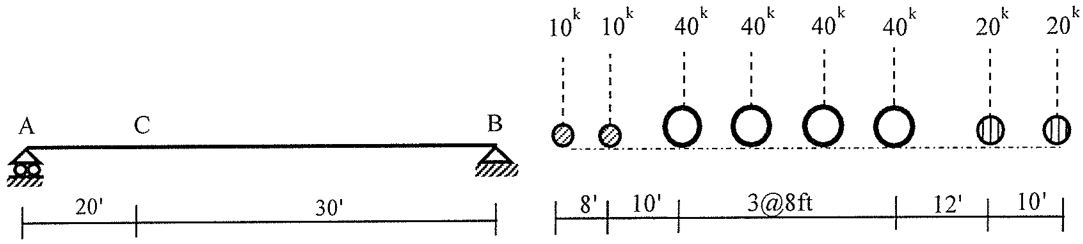


Fig.5

Formula

$\Delta V = \{(\sum P)\, d_l + P'e + P_0\, e_0\}/L - P_l$

Where, $\sum P$ = Load remaining on the influence line throughout the wheel movement,

d_l = Shift of the wheels,

P' = New load moving a distance e within the influence line,

P_l = Load which shifted off the section,

P_0 = Load moving off the influence line from a distance e_0 inside.

$\Delta M = (P_2\, d_l + P'e)\,(i/b) - (P_l\, d_l + P_0\, e_0)\,(i/a)$

Where, ΣP_2 = Load remaining on the right (increasing) portion during wheel movement,

d_l = Distance travelled by P_2. (It is the shift of load P_2)

ΣP_l = Load remaining on the left (decreasing) portion during wheel movement,

P' = Load that moves inside the span during motion,

e = Distance travelled by P' on the span,

P_0 = Load moving off the influence line from a distance e_0 inside.

$$\frac{W}{L} = \frac{W_1}{a}$$

Where, W = Total wheel loads on Span,

L = Total span length,

W_l = Total wheel loads on decreasing portion,

a = Decreasing portion distance.

PART-B

5. Analyze the frame shown in ***Fig.B1*** and draw the shear force and bending moment diagram. **[15]**

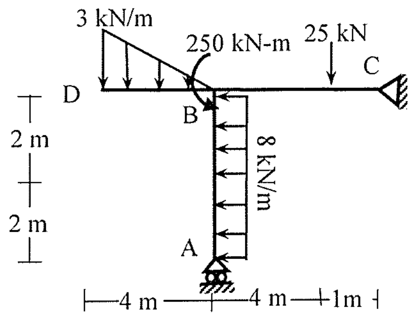


Fig.B1

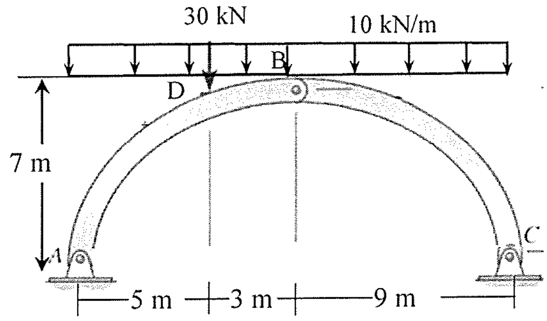


Fig.B2

6. The three-hinged arch is subjected to the loading shown in ***Fig.B2***. Analyze the arch to determine the reactions at *A* and *C*, and Draw the bending moment diagram. **[5]**

7. For the suspension bridge with parabolic cable and two stiffening trusses shown in ***Fig.B3***, determine the maximum and minimum tension of the cable. The trusses are pin connected at C, supported by a pin at A and roller at B. Determine the forces of the members **DE** and **DF**.

[16]

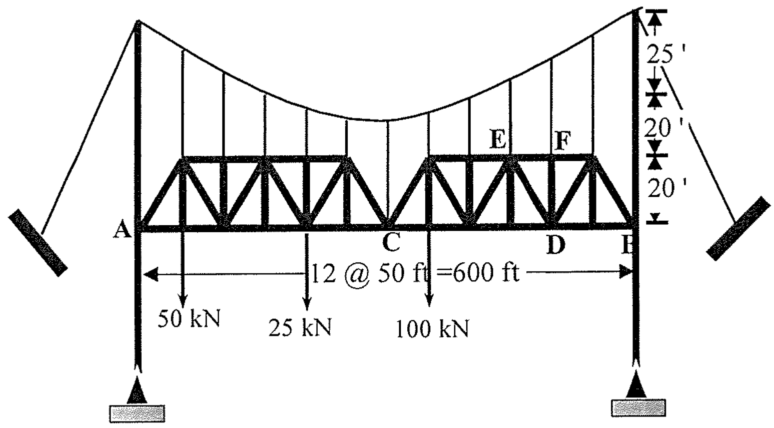


Fig.B3

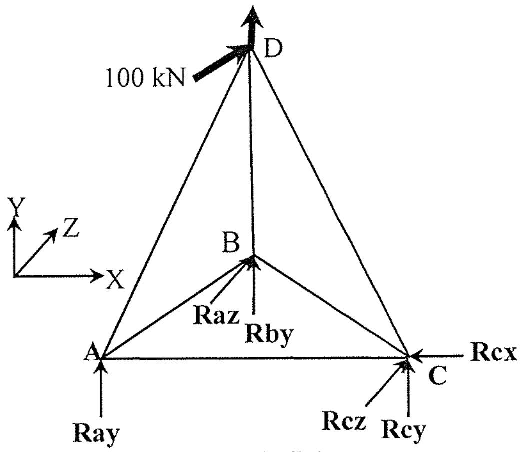


Fig.B4

8. Analyze the space truss shown in ***Fig.B4*** to determine the reactions and forces of members *CD* and *AC*.
[Nodal Coordinates (in meter) are A (0,0,0), B (5,0,8), C (6,0,0) and D (4,8,7)] **[14]**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2024
Program: B.Sc. in Civil Engineering

Course Title: Design of Concrete Structures I   Course Code: CE 315   Credit: 3.0
Time: 3 hour   Full Marks: 100

Answer all questions

Question 01: **[20]**

A beam section is limited to b = 12 in. and a total depth h = 20 in. and is subjected to a factored moment M_u =298.4 K·ft. Design the beam for the necessary reinforcement using f'_c = 4ksi and f_y =60 ksi.

Question 02: **[20]**

The floor system shown in Fig. 1 consists of 3-in. slabs supported by 14-ft-span beams spaced 10 ft on center. The beams have a web width, b_w, of 14 in. and an effective depth, d, of 18.5 in. Design the beam for the necessary reinforcement for a typical interior beam if the factored applied moment is 5080 K · in. Use f'_c = 3ksi and f_y =60 ksi

Question 03: **[4+16 = 20]**

a) Illustrate with diagram, how diagonal tension is developed in beam without shear reinforcement.

b) A 17-ft-span simply supported beam has a clear span of 16 ft and carries uniformly distributed dead and live loads of 4.5 k/ft and 3.75 k/ft, respectively. The dimensions of the beam section and steel reinforcement are shown in Fig. 2. Check the section for shear and design the necessary shear reinforcement. Given f'_c = 3 ksi normal-weight concrete and f_{yt} = 60 ksi.

Question 04: **[20]**

A reinforced concrete slab is built integrally with its supports and consists of two equal spans, each with a clear span of 15 ft. The service live load is 100 psf, fc' = 4000 psi and fy = 60,000 psi. Design the slab, following the provisions of ACI code, considering safety and environmental issues.

Question 05: **[4+8+8 = 20]**

a) Explain with diagram the two types of bond failure for concrete and tensile reinforcement.

b) Fig. 3 shows a beam-column joint in a continuous building frame. The negative steel required at the end of the beam is 2.90 in^2; however, two no. 11 bars are used, (As = 3.12 in^2.) Beam dimensions are: b = 10 in.; d = 18 in and h = 21 in. The design shear reinforcement will include no. 3 stirrups, first four of which are spaced at 3 in. and the remaining stirrups spaced at a constant 5 in. spacing in the region of the support, with 1.5 in. clear cover. Normal weight concrete with f'_c = 4000 psi and steel with f_y = 60,000 psi is used. Find the development length, l_d at which the negative bars can be cut off.

i. Using the simplified equation of table 6.1
ii. Using the basic equation Eq. 6.4

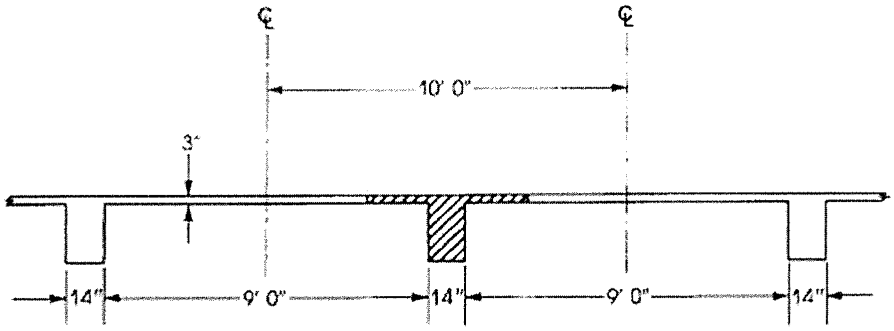


Figure 1: T-Beam floor system

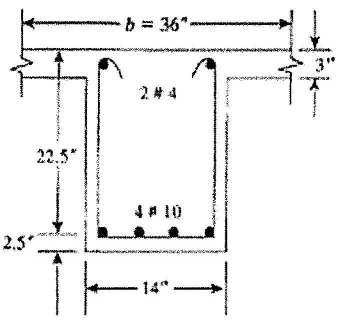


Figure 2: Section

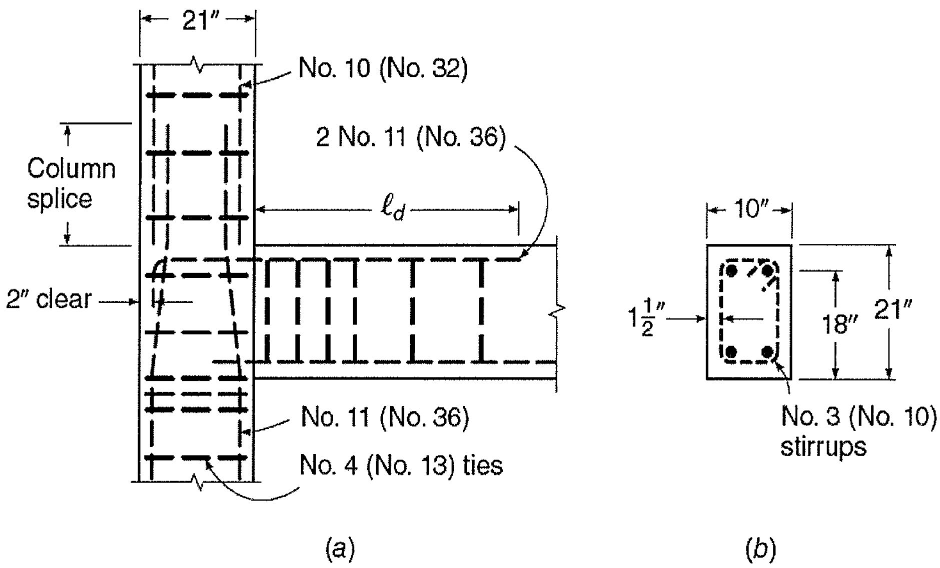


Figure 2: Bar details at beam-column joint

Formulae

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.004}$$

$$\rho_b = \alpha \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + \epsilon_y}$$

$$\varphi = 0.483 + 83.3\epsilon_t$$

$$c = \frac{\rho f_y d}{\alpha f_c'}$$

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

$$M_n = \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_c'}\right)$$

$$M_n = A_s f_y \left(d - \frac{a}{2}\right)$$

$$A_{sf} = \frac{0.85 f_c'(b - b_w) h_f}{f_y}$$

$$A_s - A_{sf} = \frac{\phi M_{n2}}{\phi f_y (d - a/2)}$$

$$V_c = 2\lambda \sqrt{f_c'} b_w d$$

$$s = \frac{\phi A_v f_{yt} d}{V_u - \phi V_c}$$

$$A_{s,min} = \frac{3\sqrt{f_c'}}{f_y} bd \geq \frac{200bd}{f_y}$$

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

$$f_s' = \epsilon_u E_s \frac{c - d'}{c}$$

$$k = \frac{n}{n + r}$$

$$j = 1 - \frac{k}{3}$$

$$M = \left[\frac{f_c(kj)}{2}\right] bd^2$$

$$\rho_{\min} = \frac{3\sqrt{f_c'}}{f_y} \geq \frac{200}{f_y}$$

TABLE 13.1
Minimum thickness *h* of nonprestressed one-way slabs

Simply supported	$l/20$
One end continuous	$l/24$
Both ends continuous	$l/28$
Cantilever	$l/10$

TABLE 11.1
Moment and shear values using ACI coefficient†

Positive moment	
End spans	
If discontinuous end is integral with the support	$\frac{1}{14} w_u \ell_n^2$
If discontinuous end is unrestrained	$\frac{1}{11} w_u \ell_n^2$
Interior spans	$\frac{1}{16} w_u \ell_n^2$
Negative moment at interior faces of exterior supports for members built integrally with their supports	
Where the support is a spandrel beam or girder	$\frac{1}{24} w_u \ell_n^2$
Where the support is a column	$\frac{1}{16} w_u \ell_n^2$
Negative moment at exterior face of first interior support	
Two spans	$\frac{1}{9} w_u \ell_n^2$
More than two spans	$\frac{1}{10} w_u \ell_n^2$
Negative moment at other faces of interior supports	$\frac{1}{11} w_u \ell_n^2$
Negative moment at face of all supports for (1) slabs with spans not exceeding 10 ft and (2) beams and girders where ratio of sum of column stiffness to beam stiffness exceeds 8 at each end of the span	$\frac{1}{12} w_u \ell_n^2$
Shear in end members at first interior support	$1.15 \frac{w_u \ell_n}{2}$
Shear at all other supports	$\frac{w_u \ell_n}{2}$

†w_u = total factored load per unit length of beam or per unit area of slab.
ℓ_n = clear span for positive moment and shear and the average of the two adjacent clear spans for negative moment.

a. Equation for Development Length for Bars and Wires in Tension

According to ACI Code 25.4.2.3, for deformed bars or deformed wires,

$$\ell_d = \left(\frac{3}{40} \frac{f_y}{\lambda\sqrt{f'_c}} \frac{\psi_t \psi_e \psi_s}{\left(\dfrac{c_b + K_{tr}}{d_b} \right)} \right) d_b \tag{6.4}$$

in which the term $(c_b + K_{tr})/d_b$ may not be taken greater than 2.5. In Eq. (6.4), the terms are defined and values established as follows.

ψ_t = casting position factor
- More than 12 in. of fresh concrete is placed below horizontal reinforcement: 1.3
- Other situations: 1.0

ψ_e = epoxy coating factor
- Epoxy-coated or zinc and epoxy dual-coated bars or wires with cover less than $3d_b$ or clear spacing less than $6d_b$: 1.5
- All other epoxy-coated or zinc and epoxy dual-coated bars or wires: 1.2
- Uncoated and zinc-coated (galvanized) reinforcement: 1.0
- However, the product of $\psi_t\psi_e$ need not be taken greater than 1.7.

ψ_s = reinforcement size factor
- No. 6 (No. 19) and smaller bars and deformed wires: 0.8†
- No. 7 (No. 22) and larger bars: 1.0

λ = lightweight aggregate concrete factor
- When lightweight aggregate concrete is used: 0.75
- However, when f_{ct} is specified, $\lambda = f_{ct}/(6.7\sqrt{f_{cm}}) \le 1.0$, where f_{cm} is the measured compressive strength.
- When normalweight concrete is used: 1.0

c_b = spacing or cover dimension, in.
- Use the smaller of either the distance from the center of the bar to the nearest concrete surface or one-half the center-to-center spacing of the bars being developed.

K_{tr} = transverse reinforcement index: $40A_{tr}/sn$

where A_{tr} = total cross-sectional area of all transverse reinforcement that is within the spacing s and that crosses the potential plane of splitting through the reinforcement being developed, in²

s = maximum spacing of transverse reinforcement within ℓ_d center to center, in.

n = number of bars or wires being developed along the plane of splitting

TABLE A.10
Simplified tension development length in bar diameters ℓ_d/d_b for uncoated bars and normalweight concrete

		No. 6 (No. 19) and Smallera			No. 7 (No. 22) and Larger		
		f'_c, psi			f'_c, psi		
	f_y, ksi	4000	5000	6000	4000	5000	6000
(1) Bottom Bars							
Spacing, cover and ties as per Case *a* or *b*	40	26	23	21	32	29	26
	60	38	34	31	48	43	39
	75	48	43	39	60	54	49
	80	51	46	42	64	57	52
Other cases	40	38	34	31	48	43	39
	60	57	51	47	72	64	59
	75	72	64	59	89	80	73
	80	76	68	62	95	85	78
(2) Top Bars							
Spacing, cover and ties as per Case *a* or *b*	40	33	30	27	42	37	34
	60	50	45	41	62	56	51
	75	62	56	51	78	69	63
	80	66	59	54	83	74	68
Other cases	40	50	45	41	62	56	51
	60	74	67	61	93	83	76
	75	93	83	76	116	104	95
	80	99	89	81	124	111	101

Case *a*: Clear spacing of bars being developed or spliced $\ge d_b$, clear cover $\ge d_b$, and stirrups or ties throughout ℓ_d not less than the Code minimum.
Case *b*: Clear spacing of bars being developed or spliced $\ge 2d_b$, and clear cover not less than d_b.
[a]ACI Committee 408 recommends that the values indicated for bar sizes No. 7 (No. 22) and larger be used for all bar sizes.

TABLE 6.1
Simplified tension development length in bar diameters according to the ACI Code

	No. 6 (No. 19) and Smaller Bars and Deformed Wires†	No. 7 (No. 22) and Larger Bars
Clear spacing of bars or wires being developed or spliced $\ge d_b$, clear cover $\ge d_b$, and stirrups or ties throughout ℓ_d not less than the Code minimum	$\ell_d = \left(\frac{f_y \psi_t \psi_e}{25\lambda\sqrt{f'_c}}\right) d_b$	$\ell_d = \left(\frac{f_y \psi_t \psi_e}{20\lambda\sqrt{f'_c}}\right) d_b$
Clear spacing of bars or wires being developed or spliced $\ge 2d_b$, and clear cover $\ge d_b$	Same as above	Same as above
Other cases	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{50\lambda\sqrt{f'_c}}\right) d_b$	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{40\lambda\sqrt{f'_c}}\right) d_b$

† For reasons discussed in Section 6.3a, ACI Committee 408 recommends that ℓ_d for No. 7 (No. 22) and larger bars be used for all bar sizes.

University of Asia Pacific
Department of Civil Engineering
Final Examination (Spring 2024)
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering I (Water Supply Engineering)	Course Code: CE 331
Time: 3 hours Credit Hours: 3.00	Full Marks: 120

Answer all the questions in both of the sections. (24+24+12+36+24= 120)
(Necessary formulae are attached; Assume reasonable data if necessary)

Section - A

1. a) A **12-inch** pipe (C =140) discharges a flow of **4.5 x 10^6 liters/day**. ***Calculate*** the **loss of head per ft** and **velocity** in the pipe. **[10]**

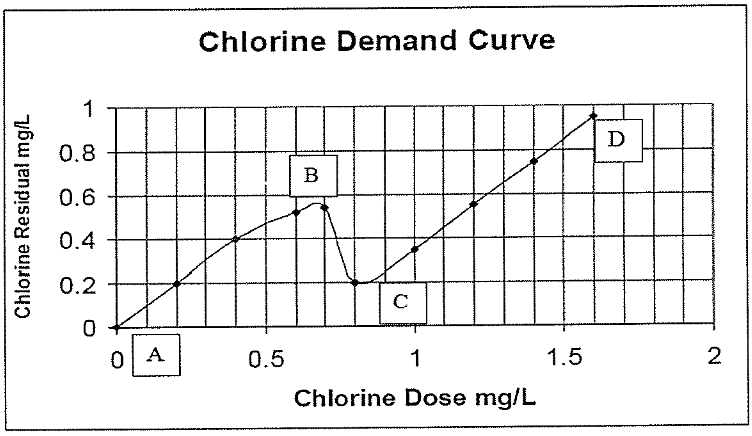
   b) A **2.5 ft diameter** cast iron pipe is laid in a trench of **5 ft wide**. The trench is filled with sand and the depth of the fill above the top of the pipe is **10 ft**. ***Calculate*** **the total load** on the pipe. **[6]**

   c) Consider a locality where you are required to install a water distribution network system using **pressure pipes**. The locality uses **groundwater** as the primary source which has **high alkalinity**. ***Discuss*** **which type of pressure pipe** will be suitable for the locality and **explain your reasons.** **[8]**

2. a) For the determination of chlorine demand for the treated water above, the following plot was generated on **Break Point Chlorination**. You need to help the plant operator in identifying the type of Chlorine residual obtained between the following points of chlorine doses. Please ***explain*** what happens (to chlorine/residual, chloro-organics and other compounds at each of the phases) if you dose as follows: **[5+7]**

   i. Between points A – B ->
   ii. Between points B – C ->
   iii. Between points C – D ->

   What are the **required chlorine doses in lbs/day** for the plant to maintain a total residual of 0.2, 0.4, mg/L, 0.3 mg/L, 0.4 mg/L and 0.6 mg/L respectively? As the design engineer, would you recommend dosing at break point or more than that? Which dose would you recommend as requirement?



b) Consider you need to provide **treatment solutions** after analysis of two different municipalities. Municipality **A** has a river water source having very high level of turbidity, low level of suspended solids and high level of coliforms while Municipality **B** has a lake water source having low level of turbidity, low level of suspended solids and low level of coliforms. ***Show*** **the flow diagrams for treatment units** for both municipalities with appropriate **justifications**. **[4+8]**

Section - B

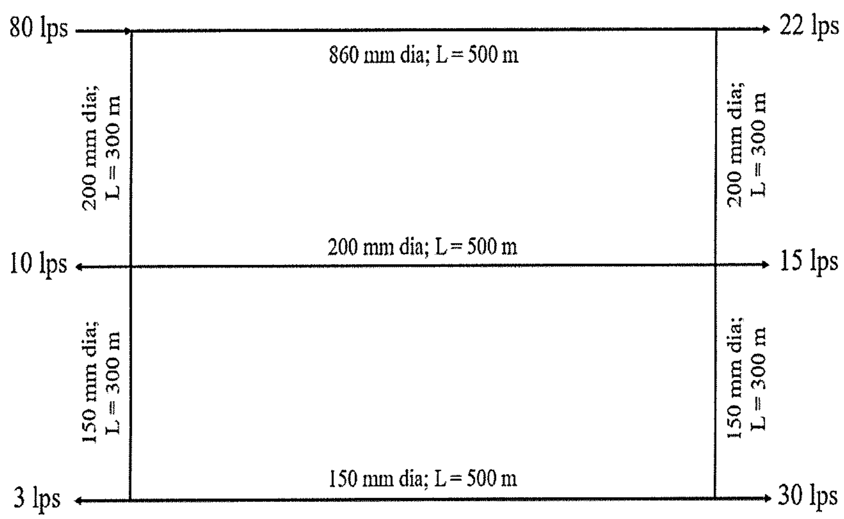
3. Answer the following questions regarding tubewell design steps: **[4+4+4]**

i) **Explain the steps** you will carry out to find out the most productive aquifer locations. Consider that aquifer samples have been collected from multiple depths of 200m, 250 m and 300 m. Values obtained are as follows respectively at increasing depths. D_{10} of 0.2 mm and C_U is 3; D_{10} of 0.4 mm and C_U is 5; D_{10} of 0.3 mm and C_U is 5. ***Write*** **with justification** about which depth of aquifer has the highest hydraulic conductivity.

ii) If the selected screen slot size is intended to retain 90% of the filter pack material, and the filter pack is composed of well-sorted quartz sand with D_{30}=0.27 mm, ***write*** the optimal slot size for the screen? Explain why slot size is important to design and how can the slots be kept clean as part of tubewell maintenance?

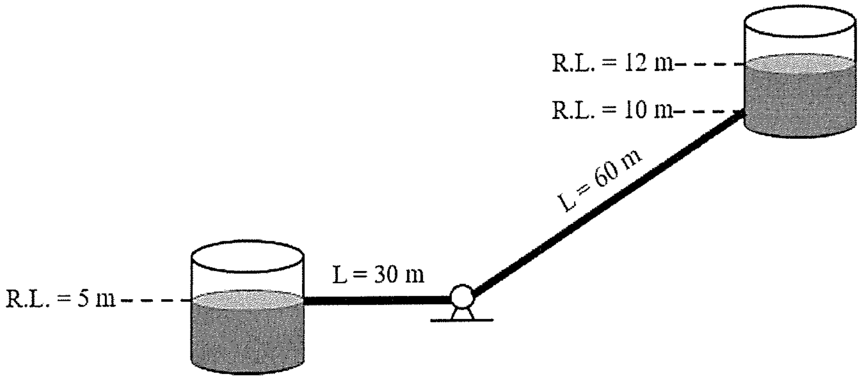
iii) The screen has a total surface area of 3 m^2 and uses a 30-slot size with an assumed opening of 15%. The flow velocity through the openings is 0.1(fps), and the factor of safety factor is 2.5. ***Calculate*** **the yield of the well** in liters per second (L/s). How would the yield change if the slot size is reduced to a 20-slot size with a corresponding opening of 10%?

4. a) ***Calculate*** **the flow** in each of the pipes in the following looped pipe network. **[14]**



b) Water ($\mathbf{v = 9x10^{-5}\ m^2/s}$) is pumped through a cast iron pipe ($\boldsymbol{\varepsilon} = \mathbf{0.04\ mm}$) from the lower tank to the upper one at a rate of **0.4 m³/s** with a velocity of **3 m/s**. [Given, $K_{Entrance} = 0.02$, $K_{Bend} = 0.4$, $K_{Exit} = 0.8$]. **[10]**

Design the **transmission main** and the **pumping unit (Efficiency = 60%)**.



c) ***Explain*** **"Household Filters"** technique as a low-cost conventional water supply system in Bangladesh to ensure safe drinking water to the people. **[6]**

d) A deep tubewell has been installed in a rural area to supply water. After a few months of operation, the **flow rate of the water drastically decreased**. ***Outline*** any method of **well maintenance** to solve the problem and **explain your reasons**. **[6]**

5. **a)** For a water safety plan, ***explain*** your understanding on **"Validation"** of Control Measure. If a system description has to cover all steps of the water supply system from source to consumer, ***outline*** a process flow diagram for the water supply system of a city that you visited inhabited by people having piped supply and also people having tubewell supply. Also **explain a plan for operational monitoring** of the system. **[5+10]**

b) Consider the System you studied as a source or to evaluate water quality in the project of CE 332 course. ***Write*** the following for the water supply system from the source in consideration, according to the Water Safety Plan: **[9]**

A. **Risk, Identification and Analysis** following the quantitative approach (attached table) based on the observed system

B. Supporting programs to implement the **Water Safety Plan.**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2024
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I	**Date: 30/12/24**	Course Code: CE 341
Time: 3 hours	Credit Hour: 3.0	Full Marks: 150

*[There are **Six** questions here. **Answer all** the questions. Related formulae, charts are given in the Appendix. Assume reasonable values of any data, if missing. Digits in the right margin inside the first parenthesis indicate marks]*

PART-A

1. (a) List and define different types of secondary structure. (5)

(b) Draw qualitative grain size distribution curves of well graded sand, uniformly graded sand and gap graded sand. (3)

(c) Classify the following two inorganic soils according to Unified Soil Classification System (USCS): (7)

Soil A : Percent finer No. 200 sieve (0.075 mm) = 93

Liquid Limit = 56%

Plastic limit = 24%

Soil B : Percent finer No. 4 sieve (4.75 mm) = 92

Percent finer No. 200 sieve (0.075 mm) = 9

D_{60} = 1.7 mm; D_{30} = 0.5 mm; D_{10} = 0.07 mm

<u>Consistency limit of fraction passing No. 200 sieve</u>

Liquid Limit = 38%

Plastic limit = 27%

(d) For an inorganic soil, the following results were obtained from grain size distribution and Atterberg limit tests:

Percent finer No. 200 sieve (0.075 mm) = 91

Liquid Limit = 57%

Plastic limit = 25%

Classify the soil based on AASHTO Soil Classification System. (5)

(e) A smooth vertical wall of height 10 m retains a saturated clay backfill of unit weight 17.5 kN/m^3. Undrained shear strength of the clay backfill is 40 kN/m^2. For undrained condition ($\phi = 0$) of the backfill, calculate the following:

(i) Depth of tension crack and unsupported height of the wall.

(ii) Active earth force after tension crack forms. (5)

2. (a) The following results were obtained in a consolidated drained (CD) direct shear test carried out on a clay sample:

Specimen No.	Normal Load (N)	Peak Shear Force (N)
1	235	159
2	470	253
3	940	444

Diameter of each specimen was 63.5 mm. Draw the failure envelope in a plain graph paper and determine the values of effective shear strength parameters (c' and ϕ') from it. Also comment on the stress history of the sample. (8)

(b) What are the advantages of triaxial compression test over direct shear test? (4)

(c) A specimen of saturated normally consolidated clay sample was fully consolidated in the triaxial cell under a cell pressure of 200 kN/m^2. Pore pressure within the specimen at the end of consolidation was zero. Deviator stress was then applied under undrained condition and increased until failure took place. The value of deviator stress at failure was found to be 300 kN/m^2. Consolidated drained triaxial compression test on an identical specimen of the sample provided $\phi' = 30°$. Determine the values of pore pressure at failure (u_f) and the pore pressure parameter A at failure (A_f) for the consolidated undrained test. (5)

(d) A vane, 100 mm height and 50 mm diameter was pressed into a clay deposit at the bottom of a borehole and the bottom of the vane is flush with the surface of the clay. Torque was applied and its value at failure was found to be 15 N-m. Assuming uniform mobilization of end shear, calculate the in-situ undrained shear strength of the clay. (4)

(e) Draw the following qualitative curves:

(i) Pore pressure versus axial strain for saturated samples of normally consolidated and heavily overconsolidated clays in consolidated (with back pressure) undrained triaxial compression tests.

(ii) Skempton's pore pressure coefficient B versus degree of saturation

(iii) Skempton's pore pressure parameter A versus axial strain for normally consolidated and overconsolidated clay. (4)

3. (a) The following results were obtained at failure in Consolidated Undrained (CU) triaxial compression tests performed on two specimens of a saturated overconsolidated clay sample:

Specimen No.	Cell Pressure (kN/m^2)	Deviator Stress (kN/m^2)	Pore Pressure (kN/m^2)
1	100	410	−65
2	200	520	−10

Draw Mohr Circles in terms of effective stresses in a plain graph paper. Draw the Mohr-Coulomb failure envelope and hence determine the values of effective shear strength parameters (c' and ϕ') from it. Also write down the Mohr-Coulomb equation for the effective stress failure envelope. **(8)**

(b) Define thixotrophy and coefficient of earth pressure at rest. **(4)**

(c) Explain the concept of passive earth pressure. Also deduce an expression for active earth pressure due to cohesionless backfill. **(5)**

(d) For the retaining wall of height 6 m shown in Fig. 1, draw Rankine's active pressure diagram and determine the total active earth force per metre length of the wall. **(8)**

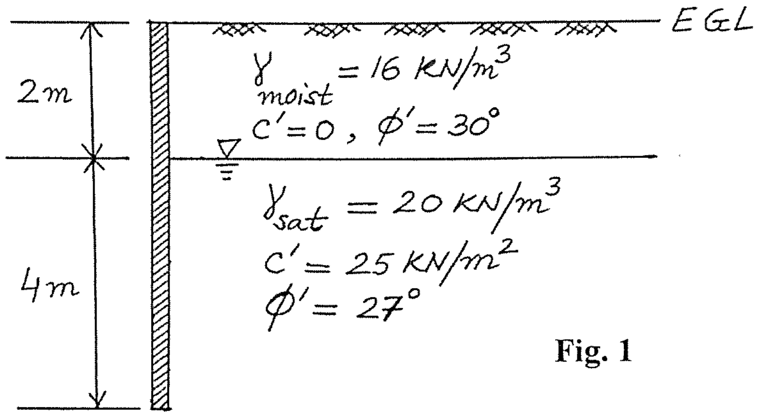
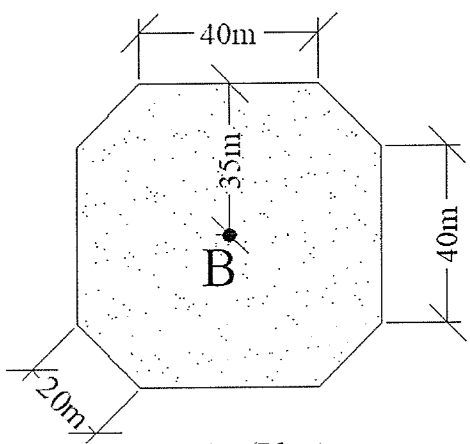


Fig. 1

PART-B

4. a) Show the relationship among void ratio and porosity of soil. **(5)**

b) The Following figures showing the base (Mat foundation) and elevation of "Empire State Building", located in New York, USA. The mat will experience a stress of 650 kPa at base level after construction. Investigation shows that, a weak soil zone is located at 25m depth below mid-point "**B**" of the base. Calculate the vertical stress at that point which is located 25m below point "B". Use Newmark Influence Chart Method. **(20)**



Mat (Plan)

Elevation

5. a) Define primary and secondary consolidation settlement. **(5)**

b) A footing is placed on a sandy layer underlying successive sand and clay strata with properties shown in **Fig. 2**. Calculate the followings. **(10+5+5)**

i. Primary consolidation settlement of the clay layer.
ii. Time required for 25.4mm settlement.
iii. Settlement after 720 months.

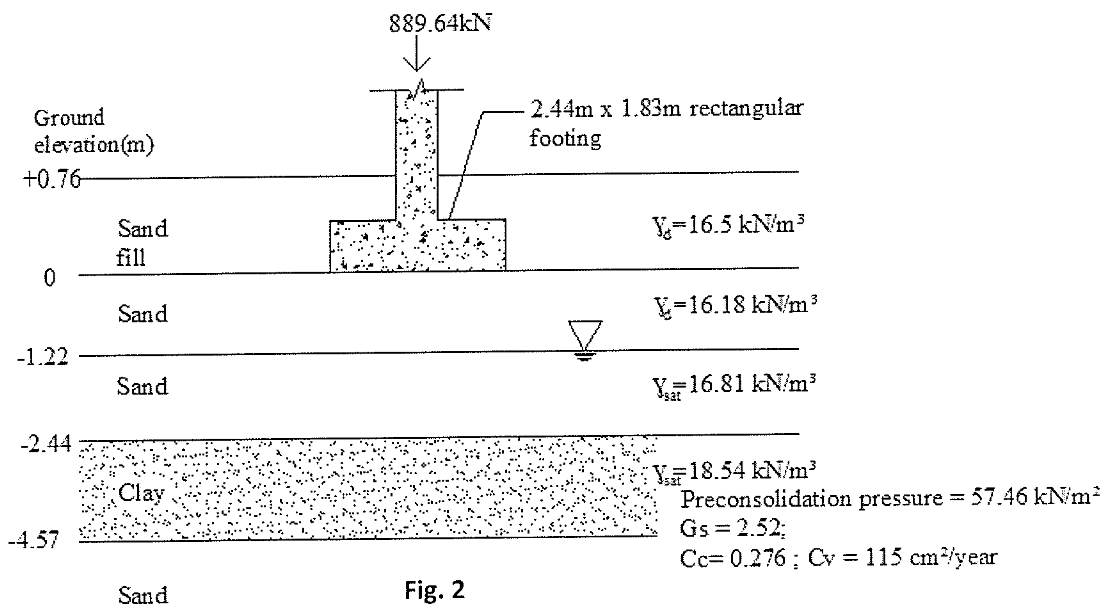


Fig. 2

6. a) Draw phase diagrams for saturated and dry soil. **(5)**

b) A **"L"** shaped mat foundation is loaded with a uniform load of 1.8 k/ft² as shown in **Fig.3**. Estimate the vertical pressure at a point which is 5ft below the point **"P"**. **(20)**

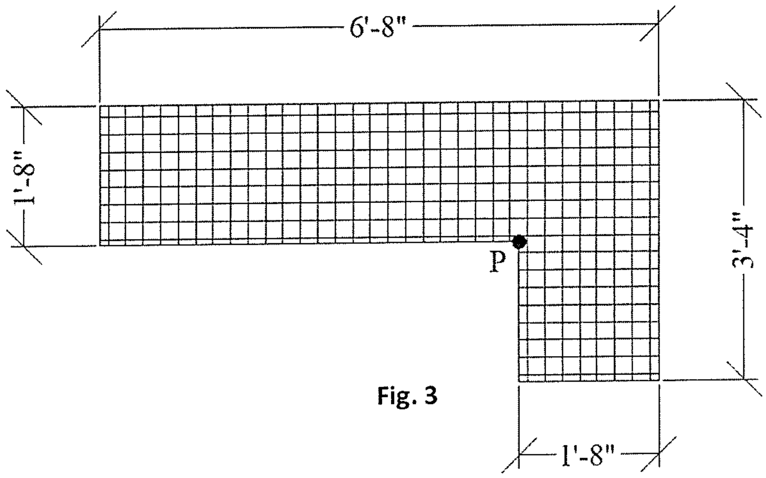


Fig. 3

Appendix

Equation of A-Line: PI = 0.73 (LL – 20)

Group Index (GI) = (F – 35)[0.2 + 0.005 (LL – 40)] + 0.01 (F – 15) (PI – 10)

Where, PI = Plasticity index; LL = Liquid limit; F = Percent finer No. 200 sieve

Chart 1 AASHTO Soil Classification System

General Classification	Granular Material (35% or less passing No. 200 sieve)							Silt Clay Materials (More than 35% passing No. 200 Sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis; Percent Passing											
No. 10	50 max	---	---	---	---	---	---	---	...	...	...
No. 40	30 max	50 max	51 min	---	---	---	---	---	---	...	...
No. 200	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40											
Liquid Limit	---		---	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min*
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
Usual types of significant constituent materials	Stone Fragments: gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General Rating as Subgrade	Excellent to good							Fair to poor			

- Plasticity index of A-7-5 subgroup is equal to or less than L.L. minus 30.
- Plasticity index of A-7-6 subgroup is greater than L.L. minus 30.

- vertical stress at a particular depth below the surface of a uniformly loaded area of any shape_

  $$\sigma_z = q[1 - \frac{1}{\{1+\left(\frac{a}{z}\right)^2\}^{3/2}}]$$

- Stress due to finite area loading__

  a) For $\mathbf{m^2+n^2+1>m^2n^2}$

  $$\sigma_z = \frac{q}{4\pi}[\frac{2mn\sqrt{(m^2+n^2+1)}}{(m^2+n^2+1+m^2n^2)} \times \frac{m^2+n^2+2}{m^2+n^2+1} + \sin^{-1}\frac{2mn\sqrt{(m^2+n^2+1)}}{m^2+n^2+1+m^2n^2}]$$

  b) For $\mathbf{m^2+n^2+1<m^2n^2}$

  $$\sigma_z = \frac{q}{4\pi}[\frac{2mn\sqrt{(m^2+n^2+1)}}{(m^2+n^2+1+m^2n^2)} \times \frac{m^2+n^2+2}{m^2+n^2+1} + \pi - \sin^{-1}\frac{2mn\sqrt{(m^2+n^2+1)}}{m^2+n^2+1+m^2n^2}]$$

- Time Factor_

  For U≤60%; $T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$

  For U>60%; $T_v = 1.781 - 0.933\log_{10}(100-U\%)$

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: B.Sc. in Civil Engineering

Course Title: Open Channel Flow | Course Code: CE 361
Time: 3 hours | Credit Hour: 3 | Full Marks: 100

Answer to all questions

1. a) Classify the state of flow combining the effect of viscosity and gravity. (5)

b) State five factors that affects Manning's n. (5)

c) Derive an expression for the normal force when a jet of water strikes a stationary flat plate. (5)

Or, Derive an expression for mean velocity (Known as "The Law of Torricelli").

2. a) "Uniform flow can be steady only". Explain. (5)

b) Water flows through a 5-meter wide and rectangular channel at a mean velocity of 2 m/s having a depth of flow of 4 m. Compute the height of a smooth upward step in the channel bed to produce critical flow and the change in water level produced by the step. Neglect energy losses (friction and eddy) and consider $\alpha = 1.0$. (10)

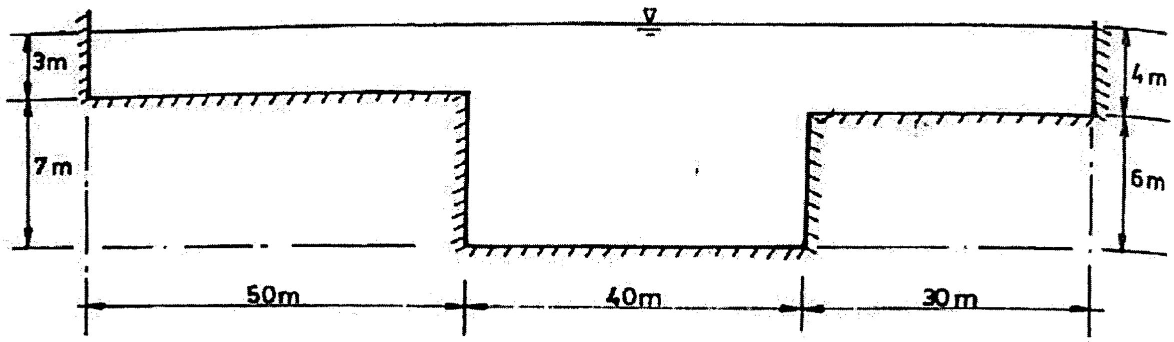
3. The data collected during the stream-gauging operation at a certain river section are given in table below. Compute the discharge and the mean velocity for the entire section. (10)

Distance from left bank (m)	Total Depth (m)	Meter depth (m)	Velocity (m/s)
0	0		
3	2	1.2	0.54
5	4	0.8 3.2	1.62 0.98
8	4.5	0.9 3.6	1.6 1.35
10	5	1 4	1.81 1.36
13	4.2	0.84 3.36	1.72 1.51
15	3.8	0.76 3.04	1.7 1.48
18	2	1.2	0.53
21	0		

4. For a trapezoidal channel with b = 7 m, s = 1.5, n = 0.027 and S_0 = 0.001, compute the normal depth and velocity when Q = 14 m^3/s. Use any numerical method. Show the first four trials. (10)

5. Show that the best hydraulic trapezoidal section is one-half of a regular hexagon. (15)

6. Compute the total discharge, the mean velocity and the Manning's n for the channel section given below. Also, compute the numerical values of α and β for the entire section. n = 0.025 for the main channel and n = 0.045 for the side channels and $S_0 = 0.0002$. $\alpha = \beta = 1$ for the main and side sections. (10)



7. A trapezoidal channel is to be laid on a slope of 1 in 1500 and carry a discharge of 52 m^3/s. It is to be excavated in earth containing slightly rounded coarse non-cohesive particles with $d_{75} = 25.4$ mm and n = 0.025. Determine the sections of the channel including freeboard. Also check for minimum permissible velocity and state of flow. Hint: s and b/h can be assumed as 2 and 4, respectively. (15)

8. Water flows in horizontal rectangular channel 7 m wide at a depth of 0.6 m and a velocity of 16 m^3/s. If a hydraulic jump occurs in this channel, determine (i) the type of jump, (ii) the downstream Froude number (iii) the relative height of the jump, (iv) the length of the jump, and (v) the efficiency of the jump (10)

Appendix
CE 361
Open Channel Flow

Given Formula (Symbols carry their usual meaning):

$$\mathrm{Fr} = \frac{\mathrm{U}}{\sqrt{\mathrm{gD}}}$$

$$\mathrm{E} = \mathrm{h} + \mathrm{U}^2/(2\mathrm{g})$$

$$h_c = \sqrt[3]{\frac{\alpha Q^2}{g b^2}}$$

$$f(h) = A^{5/3} - \frac{nQ}{\sqrt{S_0}} P^{2/3}$$

$$f'(h) = \frac{5}{3} A^{2/3} \frac{dA}{dh} - \frac{nQ}{\sqrt{S_0}} \times \frac{2}{3} P^{-1/3} \frac{dP}{dh}$$

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

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

$$K = \sqrt{1 - \frac{\sin^2 \phi}{\sin^2 \psi}}$$

$$\frac{h_2}{h_1} = \frac{1}{2}\left(\sqrt{1 + 8Fr_1{}^2} - 1\right)$$

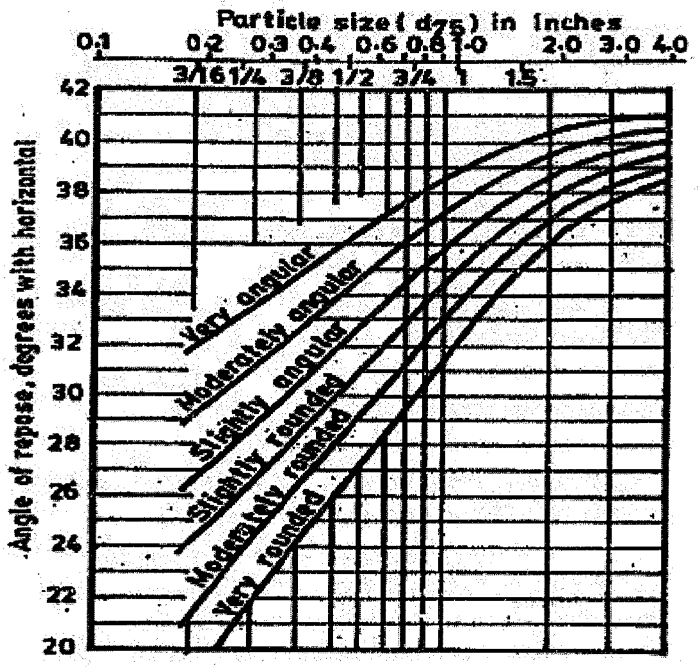
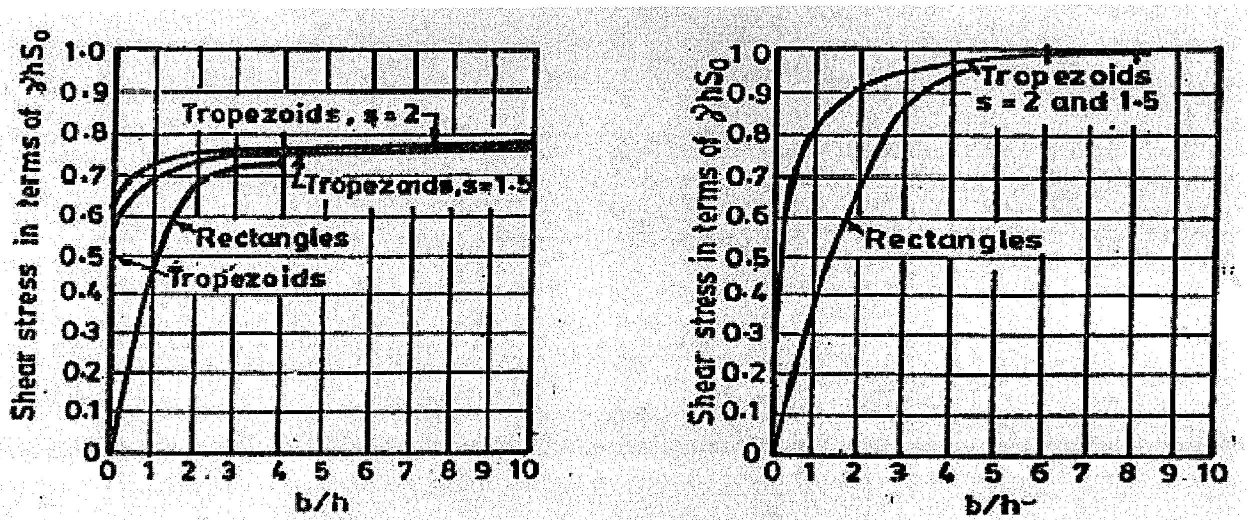


Fig.5.6 Angle of repose of non-cohesive material (Lane, 1955)



(a) On sides

(b) On bottom

Fig. 5.4 Maximum shear stresses on sides and bottom of trapezoidal channels

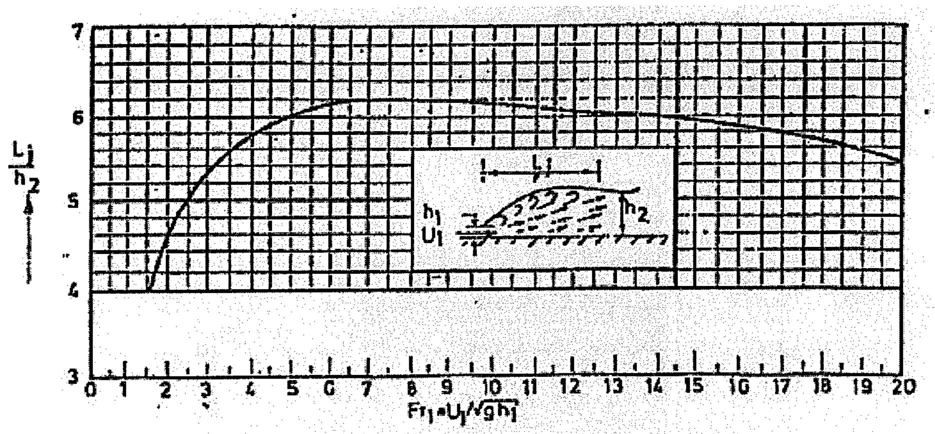


Fig.7.3 Length of hydraulic jumps in horizontal rectangular channels