3-1

# University of Asia Pacific
## Department of Civil Engineering
## Final Examination, Spring 2025
## Program: B.Sc. in Civil Engineering
## 3rd Year 1st Semester

Course Title: Business Management
Time: 3 hours

Credit Hour: 3.00

Course Code: IMG 303
Full Marks: 50

**ANSWER ANY FIVE OUT OF THE SIX QUESTIONS**

**QUESTION 1 [5+5]**

a. Discuss about different types of entrepreneurs and select the best type of entrepreneur according to you.

b. Discuss the major challenges faced by small-scale businesses in developing countries. Provide suitable examples.

**QUESTION 2 [5+5]**

a. "Hygiene factors only are not sufficient to motivate people, but motivator factors are also required"- do you agree with this statement? Justify this statement from the perspective of Hertzberg's two-factor Theory.

b. Discuss about Vroom's Theory of Expectancy with relevant examples.

**QUESTION 3 [7+3 ]**

a. A sportswear brand is launching a new collection of shoes. They want to target young adults in cities who enjoy exercising, have a high interest in fashion, and often shop online. Based on this example, can you identify and describe the four types of market segmentation being used?

b. Differentiate between B2B and B2C market.

**QUESTION 4 [5+5]**

a. A renowned manager, Ms. Shurovi is implementing a new system in her office but some of her team members are resisting this change and are anxious about the unknown. How can Ms. Shurovi guide them through this change smoothly?
b. Briefly describe the " Human Resource Management" process.

**QUESTION 5 [5+5]**

a. A company has four key products:

   Smartphone: rapidly growing market share in a high-growth industry.

   Laptop: stable sales in a mature market.

   MP3 player: declining sales in a shrinking market.

   Smart home device: emerging product in a fast-growing market but with low market share.

   Based on the BCG matrix, identify which category (Star, Cash Cow, Dog, Question Mark) each product belongs to and suggest how the company should allocate resources to maximize growth and profitability.

b. Discuss about different types of competitive strategies.

**QUESTION 6 [2.5*4=10]**

Shortly discuss **any four** of the following concepts:

a. Entrepreneur
b. Interpersonal Communication
c. Grapevine
d. Mass Marketing
e. Tactical Planning
f. MBO (Management by Objectives)
g. The Production Era of marketing

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination, Spring 2025
# Program: B.Sc. in Civil Engineering
# 3rd Year 1st Semester

Course Title: Structural Engineering I | Course Code: CE 311
Time: 3 Hour | Credit Hours: 3.00 | Full Marks: 100

**Answer all the questions**
**Assume any missing data reasonably**
**PART A**

**QUESTION 1 [12 MARKS]** **[12]**

For the wheel load arrangement shown in **Figure 2**

a) Calculate the maximum reaction at A and

b) Calculate the maximum shear at P for the beam shown in **Figure 1(b)**

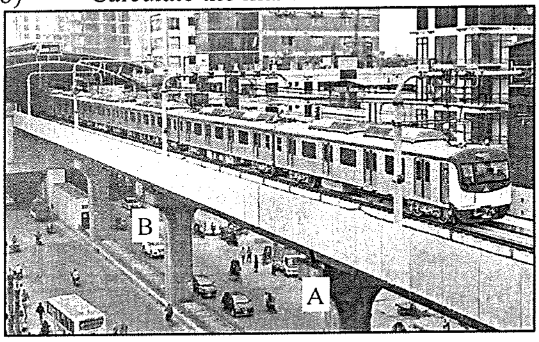



**Figure 1 (a):** Metro rail at Dhaka

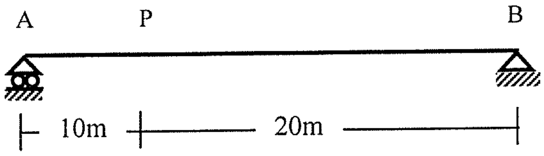



**Figure 1 (b):** A simply supported beam representing the span of the metro rail

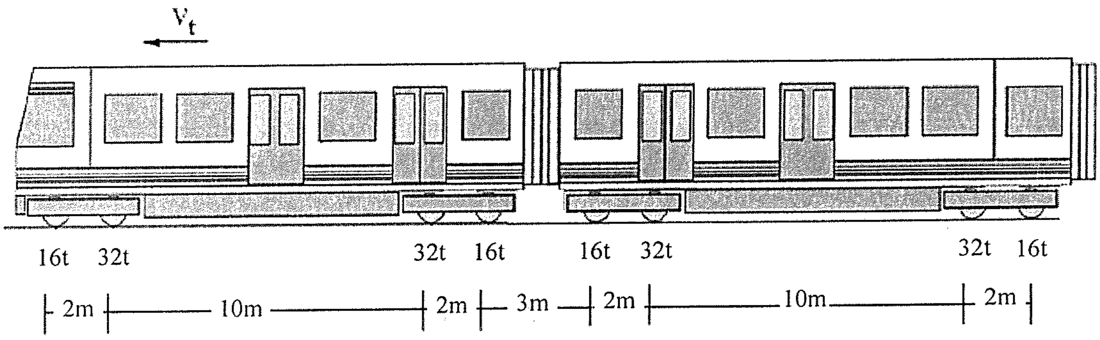



**Figure 2:** Wheel load arrangement (wheel loads in tons)

**QUESTION 2 [8 MARKS]** **[8]**

Calculate the greatest maximum moment within the span CE of the beam shown in **Figure 3.**

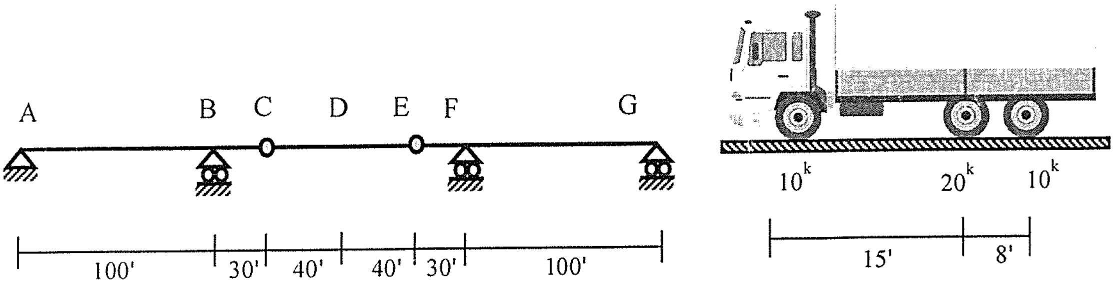



**Figure 3**

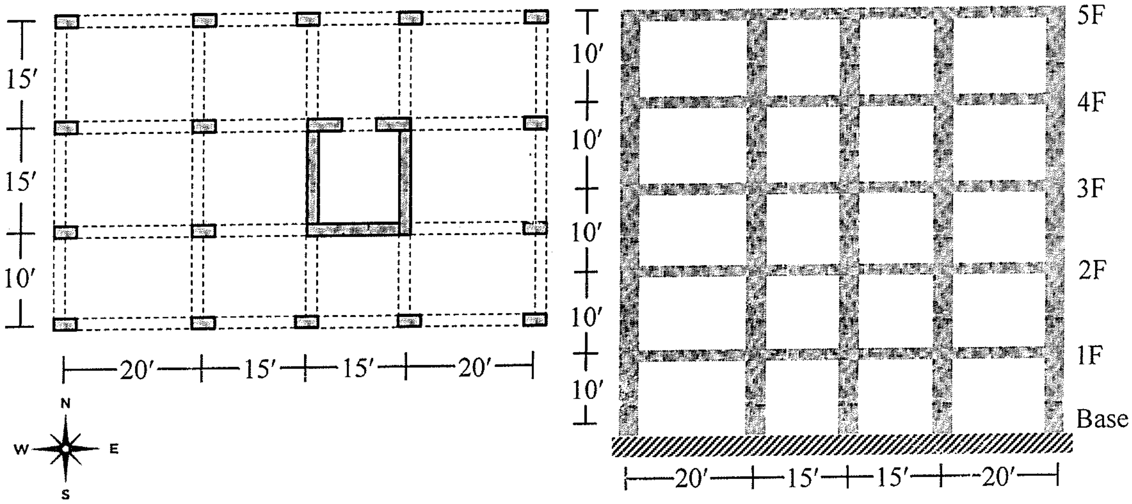
## QUESTION 3 [15 MARKS]

[15]

Use the Equivalent Static Force Method to calculate the seismic load distribution at each storey of a five-storey residential building (as shown in **Figure 4**) located in Dhaka. Assume the structure is a dual system with special shear walls. The building carries a dead load (DL) of 200 lb/ft² and a live load (LL) of 50 lb/ft².
*(Hint: Seismic Weight, $W = DL + 0.25 \times LL$)*

Note: **For odd roll numbers**, Soil Type = SD
**For even roll numbers**, Soil Type = SC

i. Calculate the Base Shear (V).
ii. Determine the Vertical Distribution of Lateral Forces at each storey of the building along the west–east (W–E) direction.




Building Plan	South Elevation

**Figure 4:** Plan and Elevation of a five-storey residential building

## QUESTION 5 [15 MARKS]

[15]

Calculate the wind load in the west–east (W–E) direction at each storey of a five-story residential building (as shown in **Figure 4**) located on flat terrain in Dhaka. Assume that the structure is subjected to Exposure Category B and Basic wind speed of Dhaka is 147 mph.

## QUESTION 6 [5 MARKS]

[5]

Calculate the topographic factor, $K_{zt}$, for a building (as shown in **Figure 5**) located on a two-dimensional escarpment under Exposure C, given that the building height is z =50 ft.

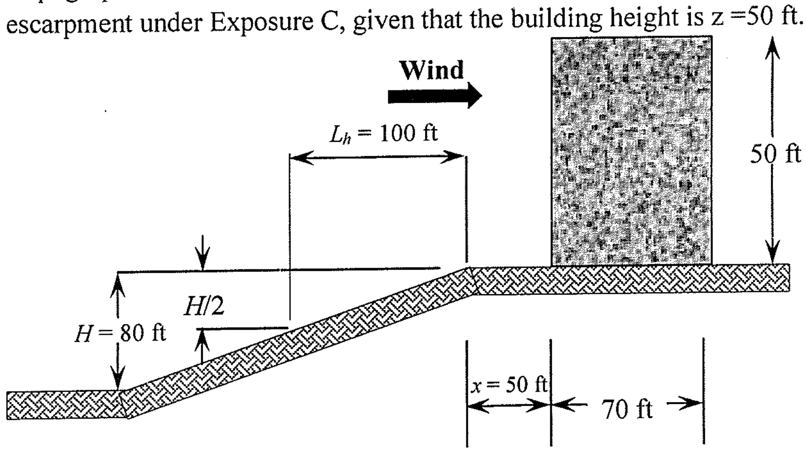



**Figure 5:** 2-dimensional escarpments

## QUESTION 6 [10 MARKS] [10]

For the truss shown in **Figure 6**,

a) Calculate the maximum reaction at support "*a*" and

b) Calculate maximum compression and tension forces in members *ab* and *eb*, when a concentrated live load of **20 kN for odd roll numbers** or **29 kN for even roll numbers** moves over the stringers.

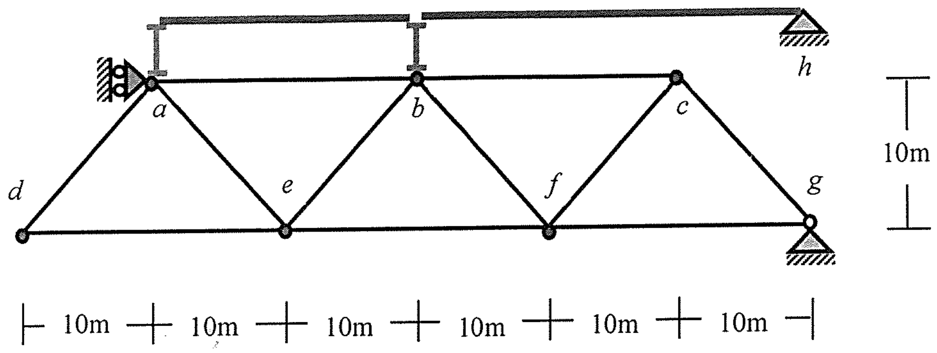



**Figure 6:** Truss

**Answer all the questions**
**Assume any missing data reasonably**
**PART B**

## QUESTION 7 [10 MARKS] [10]

Determine the force in member AF, FC & BF of the truss in **Figure 7** in approximate method. Assume the diagonals can support equal amount of tensile or compressive force.

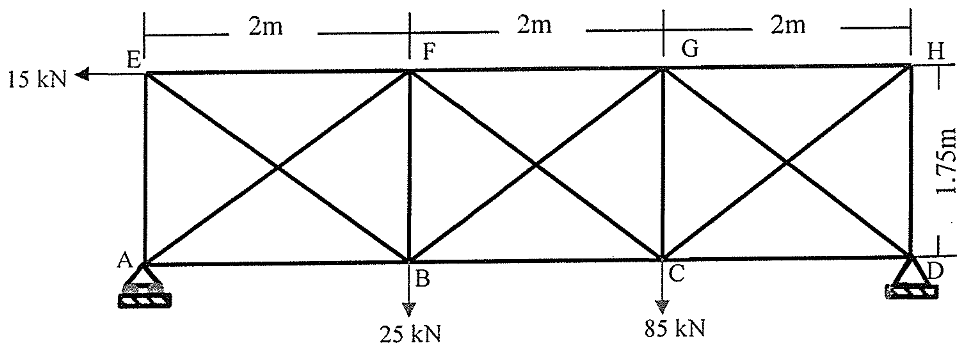



**Figure 7**

## QUESTION 8 [4 MARKS] [4]

Determine (approximately) the support **reactions** at A & B of the frame shown in **Figure 8**

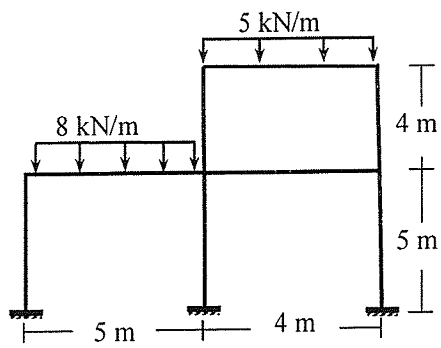



**Figure 8**

## QUESTION 9 [8 MARKS] [8]

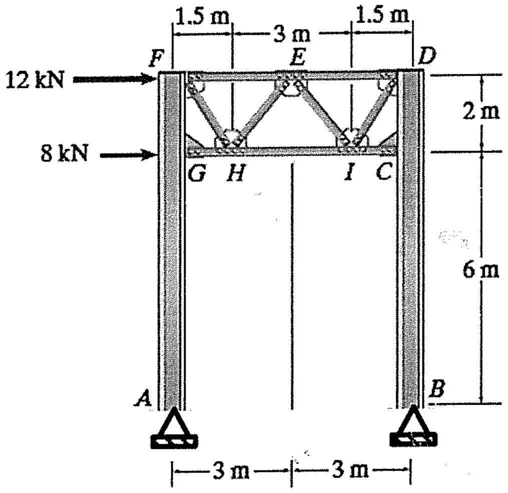



Figure 9

In the bridge portal shown in **Figure 9**, draw the BMD and SFD of the member BCD using portal method. Assume all members of the truss to be pin connected at their ends and the supports at A and B are pinned.

## QUESTION 10 [13 MARKS] [13]

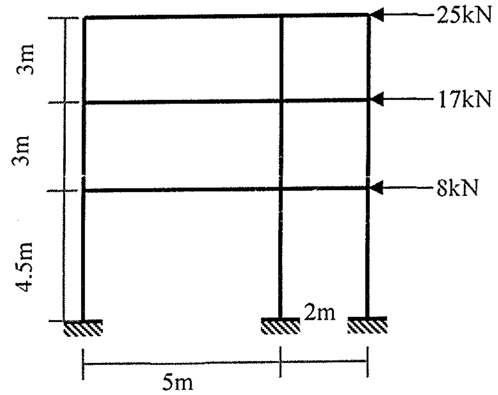



**Figure 10 (a)**

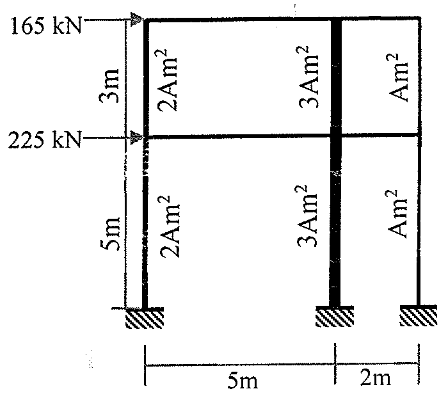



**Figure 10 (b)**

(a)Analyze the frame shown in **Figure 10 (a)** by Portal Method to draw the Shear Force and Bending Moment diagrams.

**OR**

(b)Analyze the frame shown in **Figure 10 (b)** by Cantilever Method to draw the Shear Force & Bending Moment diagrams.

**Formula**

$\Delta R = \{(\sum P)\, d_1 + P'e\}/L - P_1$

$\Delta V = \{(\sum P)\, d_1 + P'e + P_0\, e_0\}/L - P_1$

Where, $\sum P$ = Load remaining on the influence line throughout the wheel movement,
$d_1$ = Shift of the wheels,
$P'$ = New load moving a distance $e$ within the influence line,
$P_1$ = Load which shifted off the section,
$P_0$ = 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,
$W_1$ = Total wheel loads on decreasing portion,
a = Decreasing portion distance.

**University of Asia Pacific**
**Department of Civil Engineering**
**Final Examination, Spring 2025**
**Program: B.Sc. in Civil Engineering**
**3rd Year 1st Semester**

Course Title: Structural Engineering I (old) | Course Code: CE 311(old)
Time: 3 Hours | Credit Hours: 3.00 | Full Marks: 100

**Answer all the questions**
**Assume any missing data reasonably**

## QUESTION 1 [10]

In **Figure 1**, Determine the horizontal and vertical components of reaction at A and C of the three-hinged arch. Assume A, B, and C are **pin connected.**

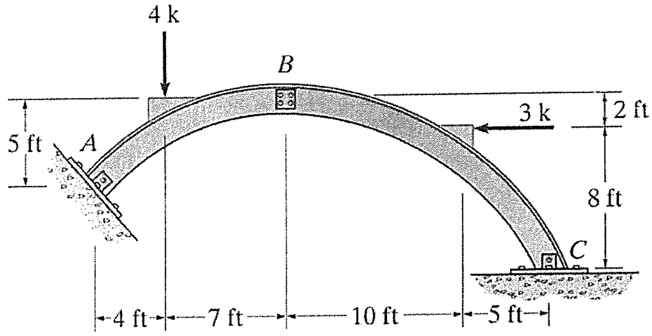



**Figure 1**

10
## QUESTION 2 [8 MARKS] [10]

Analyze the TRUSS shown in **Figure 2** and draw the influence lines for FG, GC, CD & DI.

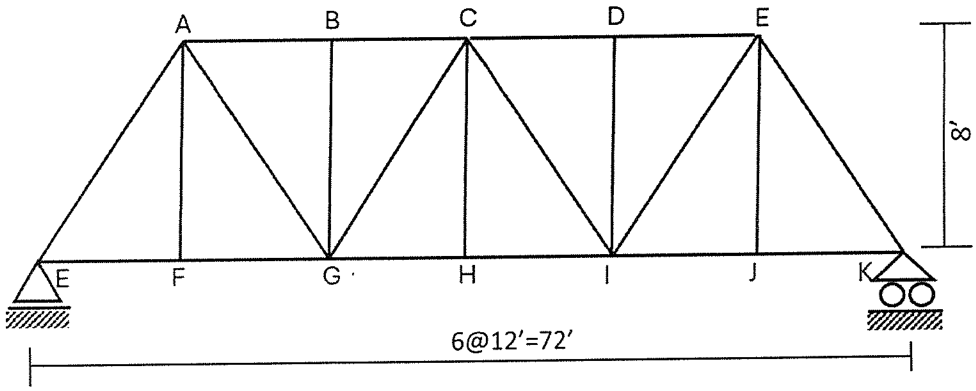



**Figure 2**

## QUESTION 3 [12 MARKS] [12]

Analyze the plate girder ABCDEFG shown below in **Figure 3**, and draw the influence lines for Moment at E (**$M_E$**) and Shear in panel AC (**$V_{AC}$**), if unit load passes over the stringers.

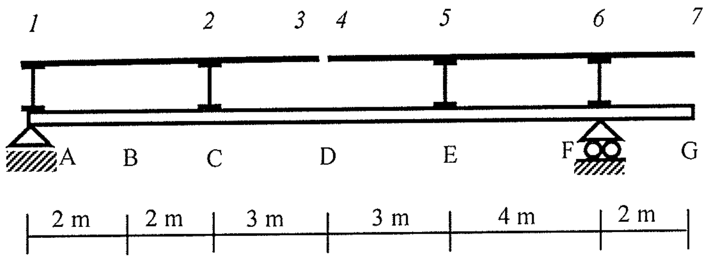



**Figure 3**

**QUESTION 4 [15 MARKS]** **[15]**

Analyze the frame shown in **Figure 4** and draw the influence lines for Vertical Reaction at A (**$Y_A$**), Shear force at C (**$V_C$**), and Bending moment at C (**$M_C$**) if the unit horizontal load moves over column AB.

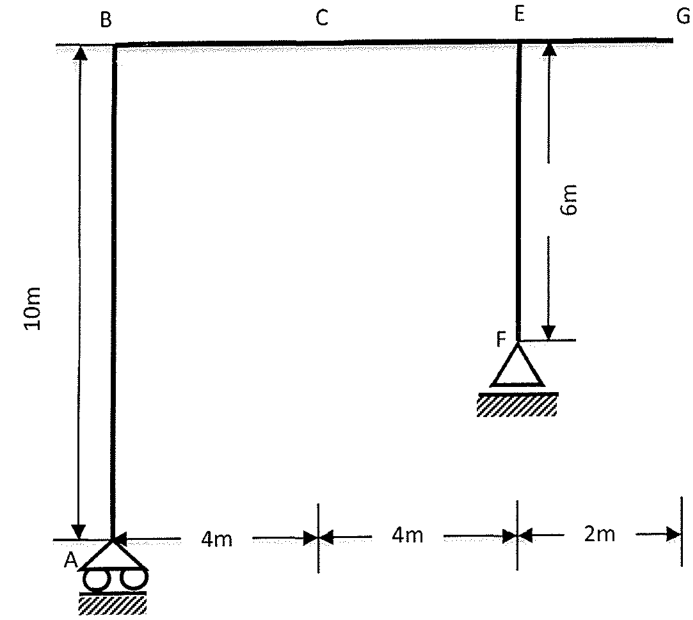



**Figure 4**

**QUESTION 5 [20 MARKS]** **[10+10]**

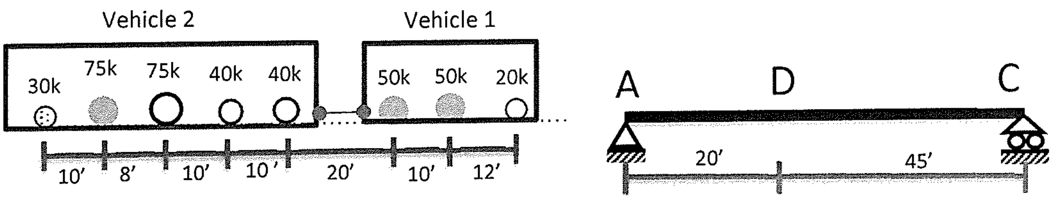



**Figure 5**

Analyze the beam shown in **Figure 5** to determine:

a. The Maximum Shear force at D due to the wheel loads moving from left to right of the beam (From A to C)

b. The Maximum Bending Moment at D, considering the wheel loads moving from left to right.

## QUESTION 6 [13 MARKS] [13]

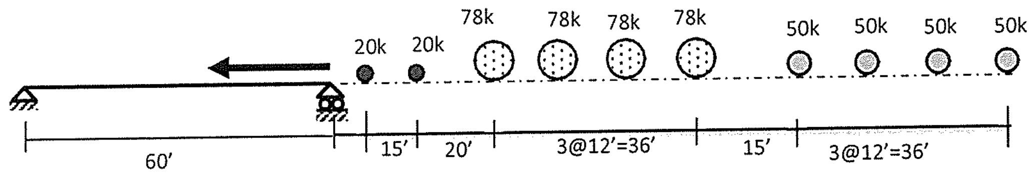



**Figure 6**

Analyze the beam in **Figure 6** and find the "Greatest Maximum Moment" (GMM) of the beam for the given loads

## QUESTION 7 [20 MARKS] [20]

The given structural system (Residential Building) in **Figure 7** is **Intermediate Moment Resisting Concrete Frame** and the **site class is SC**. Dead load and partition wall load = 12 kN/m$^2$ for typical floors including roof and ground floor. Live load of typical floor is 2.0 kN/m$^2$ including ground floor, and live load in the roof is 1 kN/m$^2$. Also given that self-weight of all pedestals is 120 kN.

Given Seismic Zone coefficient= 0.2 (Zone=2) and Importance factor 1(Occupancy Category=II). For T<0.5s, k=1 and for T>2.5s, k=2. And the damping ratio for concrete structure is 5% (ξ)

a. Calculate the earthquake base shear using Equivalent Static Force Method.

b. Determine floor-wise shear force distribution

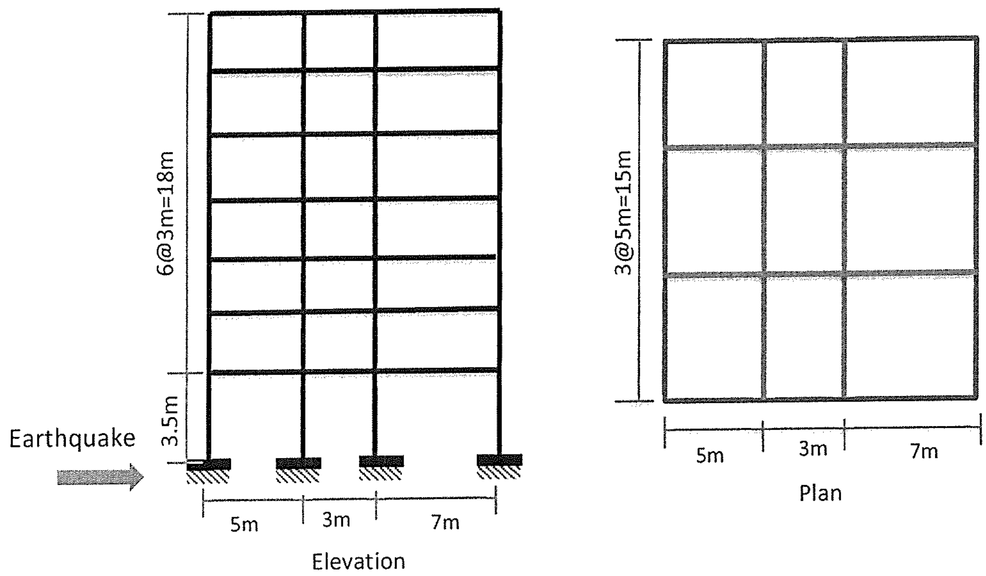



**Figure 7**

# Annex

$$\Delta M = (P_2 d_1 + P' e)(i/b) - (P_1 d_1 + P_0 e_0)(i/a)$$

$$\Delta V = \{(\Sigma P) d_1 + P' e + P_0 e_0\}/L - P_1$$

$$\Delta R_{1\text{-}2} = \frac{(\Sigma P)\times d_1}{L} + \Sigma\left(\frac{P'\times e}{L}\right) - P_1$$

$$S_a = \frac{2}{3}\frac{ZI}{R}C_s$$

$$C_s = S\left(1 + \frac{T}{T_B}(2.5\eta - 1)\right) \quad \text{for} \quad 0 \le T \le T_B$$

$$C_s = 2.5S\eta \quad \text{for} \quad T_B \le T \le T_C$$

$$C_s = 2.5S\eta\left(\frac{T_C}{T}\right) \quad \text{for} \quad T_C \le T \le T_D$$

$$C_s = 2.5S\eta\left(\frac{T_C T_D}{T^2}\right) \quad \text{for} \quad T_D \le T \le 4\ sec$$

$$\eta = \sqrt{10/(5+\xi)} \ge 0.55$$

$$T = C_t (h_n)^m$$

$$F_x = V\frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$$

Table 6.2.16: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

| Soil type | $S$ | $T_B$(s) | $T_C$(s) | $T_D$(s) |
|---|---|---|---|---|
| SA | 1.0 | 0.15 | 0.40 | 2.0 |
| SB | 1.2 | 0.15 | 0.50 | 2.0 |
| SC | 1.15 | 0.20 | 0.60 | 2.0 |
| SD | 1.35 | 0.20 | 0.80 | 2.0 |
| SE | 1.4 | 0.15 | 0.50 | 2.0 |

Table 6.2.18: Seismic Design Category of Buildings

| Site Class | Occupancy Category I, II and III | | | | Occupancy Category IV | | | |
|---|---|---|---|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
| SA | B | C | C | D | C | D | D | D |
| SB | B | C | D | D | C | D | D | D |
| SC | B | C | D | D | C | D | D | D |
| SD | C | D | D | D | D | D | D | D |
| SE, $S_1$, $S_2$ | D | D | D | D | D | D | D | D |

**Table 6.2.19: Response Reduction Factor, Deflection Amplification Factor and Height Limitations for Different Structural Systems**

| Seismic Force–Resisting System | Response Reduction Factor, $R$ | System Overstrength Factor, $\Omega_o$ | Deflection Amplification Factor, $C_d$ | Seismic Design Category B | Seismic Design Category C | Seismic Design Category D |
|---|---|---|---|---|---|---|
| | | | | Height limit (m) | | |
| 4. Special reinforced concrete moment frames | 8 | 3 | 5.5 | NL | NL | NL |
| 5. Intermediate reinforced concrete moment frames | 5 | 3 | 4.5 | NL | NL | NP |
| 5. Ordinary reinforced concrete moment frames | 3 | 3 | 2.5 | NL | NP | NP |

**Table 6.2.20: Values for Coefficients to Estimate Approximate Period**

| Structure type | $C_t$ | $m$ | |
|---|---|---|---|
| Concrete moment-resisting frames | 0.0466 | 0.9 | Note: Consider moment resisting frames as frames which resist 100% of seismic force and are not enclosed or adjoined by components that are more rigid and will prevent the frames from deflecting under seismic forces. |
| Steel moment-resisting frames | 0.0724 | 0.8 | |
| Eccentrically braced steel frame | 0.0731 | 0.75 | |
| All other structural systems | 0.0488 | 0.75 | |

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination, Spring 2025
# Program: B.Sc. in Civil Engineering
# 3rd Year 1st Semester

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

*Answer all questions*

**QUESTION 1 [20 MARKS]**

a) Illustrate with diagram, how diagonal tension is developed in beam without shear reinforcement.
b) Explain with diagram the two types of bond failure for concrete and tensile reinforcement.
c) Explain with diagram the different specifications of hook anchorage of rebar.
d) Discuss the significance of temperature and shrinkage reinforment in slabs.

**[4*5 = 20]**

**QUESTION 2 [20 MARKS]**

The floor system shown in Fig. 1 consists of 5-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 according to BNBC 2020 and following the environmental and safety measures for the necessary reinforcement of a typical interior beam if the factored applied moment is 5080 k-in. Use $f'_c$ = 3ksi and $f_y$ =60 ksi

**[20]**

**QUESTION 3 [20 MARKS]**

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. Apply the design concept to obtain the necessary shear reinforcement of the beam. Given $f'_c$ = 3 ksi normal-weight concrete and $f_{yt}$ = 60 ksi.

**[20]**

**QUESTION 4 [20 MARKS]**

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.

**[20]**

**QUESTION 5 [20 MARKS]**

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

**[10 + 10 = 20]**

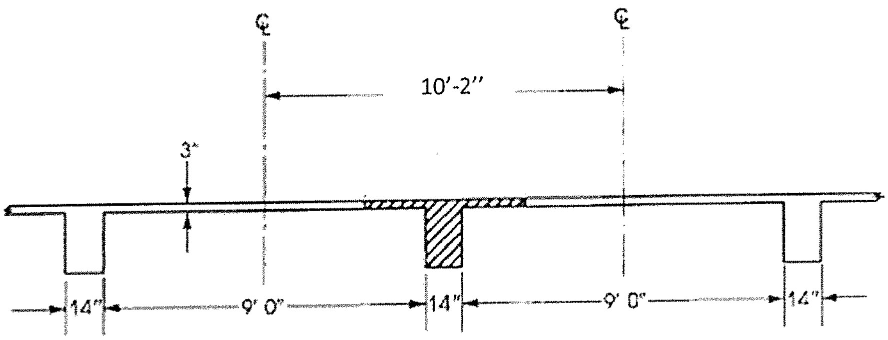



**Figure 1: T-Beam floor system**

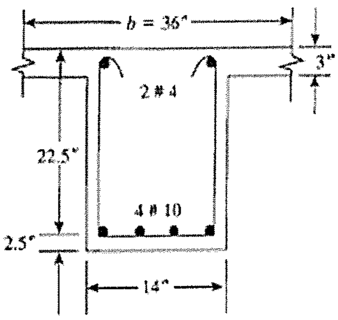



**Figure 2: Section**

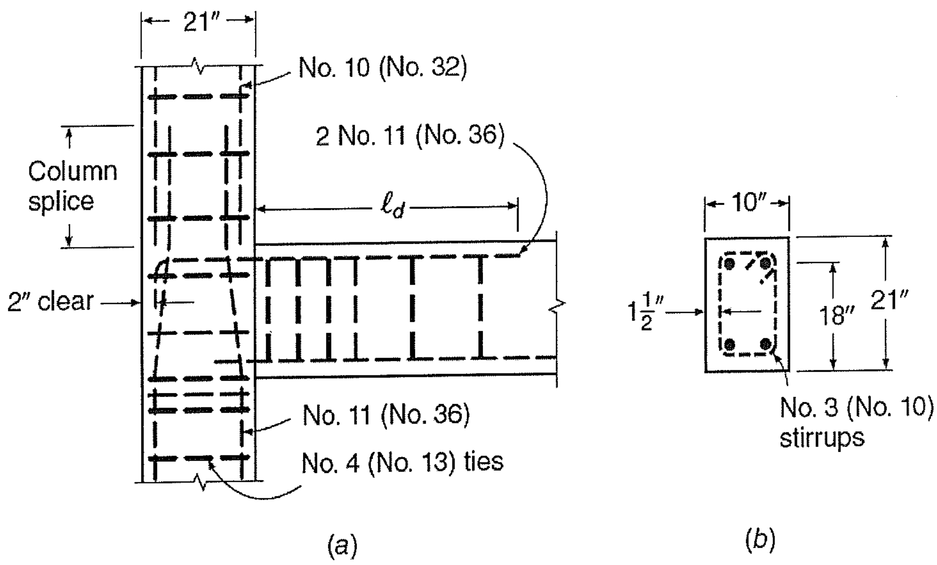



**Figure 3: Bar details at beam-column joint**

# University of Asia Pacific
## Department of Civil Engineering
## Final Semester Examination, Spring 2025
## Program: B.Sc. in Civil Engineering
## 3rd Year 1st Semester

Course Title: Environmental Engineering I(old) | Course Code: CE 331
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 120

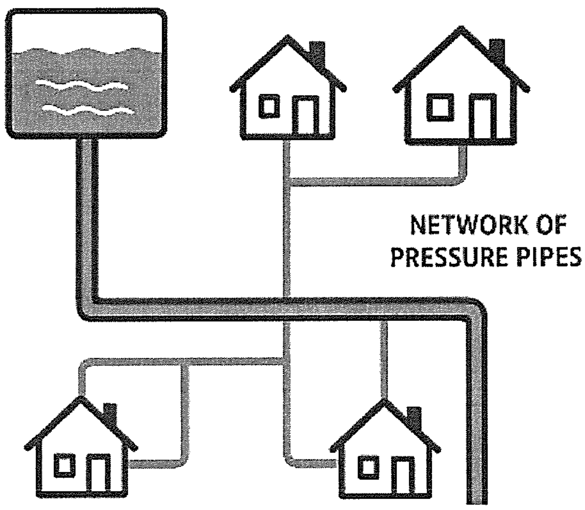
**There are four questions here. Answer all the questions.**
**(Necessary formulae/tables/charts are attached; Assume reasonable data if necessary)**

**QUESTION 1 [24 MARKS]**

(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. [7]

(c) Refer to the figure below, which illustrates a simple water distribution network system using pressure pipes. Consider a locality where such a system is to be installed. The area depends on groundwater as the primary water source, which has high alkalinity. Among cast iron, PVC, and concrete pipes, determine the most suitable type of pressure pipe for this locality and justify your choice with appropriate reasoning. [7]



## QUESTION 2 [24 MARKS]

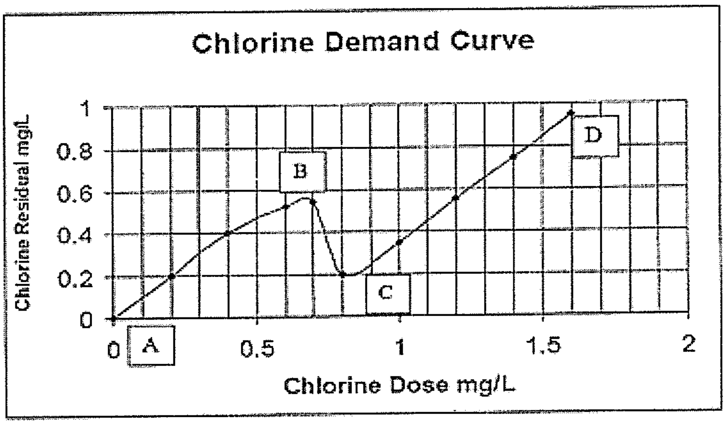
(a) For the determination of chlorine demand for the treated water above, the following plot was generated on **Break Point Chlorination**. You need to help the plant operator in identifying the type of Chlorine residual obtained between the following points of chlorine doses. Please explain what happens (to chlorine/residual, chloro-organics and other compounds at each of the phases) if you dose as follows: [7+7=14]

i. Between points A - B ->

ii. Between points B - C ->

iii. Between points C - D ->

What are the required chlorine doses in mg/L for the plant to maintain a total residual of 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 that you are tasked with designing suitable water treatment systems for two different municipalities based on the characteristics of their water sources. [5+5]

- **Municipality A:** River water source with **very high turbidity, low suspended solids**, and **high coliform levels**.
- **Municipality B:** Lake water source with **low turbidity, low suspended solids**, and **low coliform levels.**

Draw the **flow diagrams** showing the **treatment units** required for each municipality and provide **appropriate justifications** for the selection and arrangement of the treatment processes.

QUESTION 3 [28 MARKS]

(a) The following table shows the grain size characteristics of subsurface strata obtained from sieve analysis at different depths of an exploratory borehole in a potential groundwater zone. The length of the strainer was determined to 80 feet. [8+12=20]

Additional Data:

- Inside diameter of well = 8 inches
- Recommended entrance velocity ≤ 0.1 ft/s
- Screen open area = 20 %
- Factor of safety=2

| **Sample Depth (ft)** | **$D_{10}$ (mm)** | **$D_{30}$ (mm)** | **$D_{60}$ (mm)** | **$U = D_{60}/D_{10}$** | **F.M.** |
|---|---|---|---|---|---|
| 130–170 | 0.15 | 0.195 | 0.27 | 1.80 | 1.18 |
| 170–210 | 0.12 | 0.195 | 0.30 | 2.50 | 1.26 |
| 210–220 | 0.15 | 0.21 | 0.33 | 2.20 | 1.41 |
| 220–270 | 0.17 | 0.28 | 0.30 | 1.76 | 1.63 |
| 270–310 | 0.17 | 0.28 | 0.31 | 1.82 | 1.69 |
| 310–370 | 0.17 | 0.24 | 0.38 | 2.24 | 1.50 |
| 370–410 | 0.17 | 0.29 | 0.395 | 2.32 | 1.63 |
| 410–430 | 0.15 | 0.22 | 0.37 | 2.47 | 1.47 |

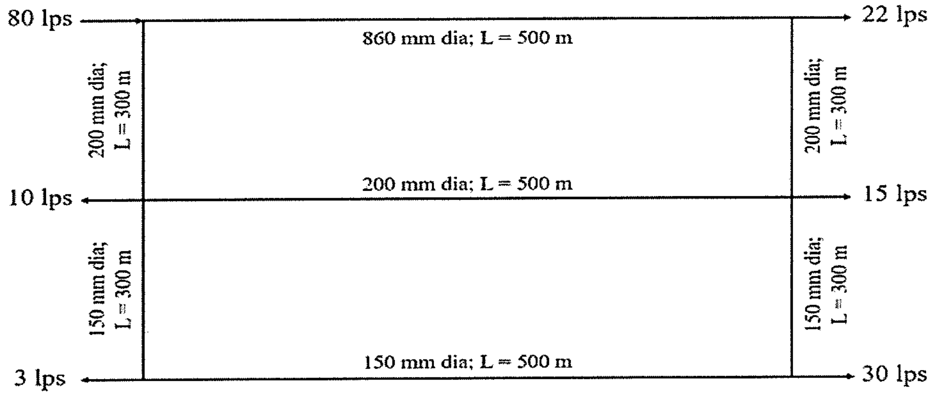
i. Identify the most productive aquifer zone and calculate the thickness of aquifer based on the above data.

ii. Estimate the expected yield of the well if pumping is done for 8 hours in a day.

(b) Explain your understanding on "**Well Development**" mentioning the targets to be achieved by effective well development. [8]

## QUESTION 4 [44 MARKS]

(a) Calculate the flow in each of the pipes in the following looped pipe network. [20]




(b) Design the **transmission main** and the **pumping unit** from the following data: [15]

Water supply rate = 40 gpcd

Estimated population = 85000

Ground R.L. at pump house = 102.50 ft

Treatment plant R.L. = 193.00 ft

Velocity through the pipes = 8 fps

Pumping time = 10 hours daily

Total length of pipe = 3500 ft

Friction factor = 0.01

Efficiency of pump = 65%

(c) The Green Valley Housing Project consists of several households planning to install rooftop rainwater harvesting systems. Each house has 6 residents, and the community aims to meet a demand of 12 L/person/day throughout the dry season using stored rainwater. The average annual rainfall intensity of the region is 2.2 m/year, and the runoff coefficient for the roof material is 0.75. [5+4=9]

Hydrological records suggest that 40% of the total annual rainfall must be stored to ensure uninterrupted supply throughout the dry period.

i. Calculate the minimum capacity of the storage tank required for one household

ii. Determine the minimum catchment area required per house.

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination, Spring 2025
# Program: B.Sc. in Civil Engineering
# 3rd Year 1st Semester

Course Title: Geotechnical Engineering I | Course Code: CE 341
Time: 3 hours | Credit Hour: 3.00 | 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 [75 MARKS]

### QUESTION 1 [25 MARKS]

a. Liquid limit test was carried out on a silty clay sample using Casagrande's apparatus and the following results were obtained:

| **No. of blows (N)** | 15 | 19 | 24 | 30 | 35 |
|---|---|---|---|---|---|
| **Water Content (%)** | 48.4 | 46.5 | 44.9 | 43.6 | 42.6 |

Plot the flow curve in a semi-log graph paper and determine the liquid limit of the sample. Also compute the flow index of the sample. [7]

b. Define structure and fabric of soil. Also, with neat sketches define various types of primary structure of coarse-grained soil. [7]

c. Draw neatly the Plasticity Chart according to Unified Soil Classification System (USCS) showing the classifications of important soil deposits. [6]

d. For a soil, the following results were obtained from grain size distribution and Atterberg limit tests:

Percent finer No. 200 sieve (0.075 mm) = 85

Liquid Limit = 58%

Plastic limit = 31%

Classify the soil based on AASHTO Soil Classification System. [5]

### QUESTION 2 [25 MARKS]

a. Explain sensitivity of clays and critical void ratio of sands.

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 | 150 | 158 |
| 2 | 350 | 263 |
| 3 | 550 | 364 |

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 $\phi'$) from it. Also comment on the stress history of the sample. [10]

b. Mention the advantages of triaxial compression test. [3]

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 values of deviator stress and pore pressure at failure were found to be 110 $kN/m^2$ and 115 $kN/m^2$, respectively. A second specimen of the same sample was fully consolidated in the triaxial cell under a cell pressure of 400 $kN/m^2$. Pore pressure within this specimen at the end of consolidation was zero. Deviator stress was then applied under undrained condition and increased until failure took place. Calculate the following analytically:

(i) the values of $\phi'$ and $\phi_u$ of the sample.

(ii) the values of pore pressure at failure ($u_f$) and the pore pressure parameter A at failure ($A_f$) of the second specimen. [7]

d. A clay sample (liquid limit = 48%, plastic limit = 24% and natural moisture content = 37%) was collected from a depth of 8 m below the existing ground level. Water table is at the existing ground level and saturated unit weight of the sample is 20 $kN/m^3$. From a laboratory one-dimensional consolidation test, the preconsolidation pressure of the sample was found to be 490 $kN/m^2$. Estimate the value of undrained shear strength of the sample at that depth. [5]

**QUESTION 3 [25 MARKS]**

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

| Specimen No. | Cell Pressure ($kN/m^2$) | Deviator Stress ($kN/m^2$) | Pore Pressure ($kN/m^2$) |
|---|---|---|---|
| 1 | 125 | 510 | −70 |
| 2 | 250 | 620 | −10 |

Draw Mohr Circles of the specimens 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 $\phi'$) of the sample from the failure envelope. Also write down the Mohr-Coulomb equation for the effective stress failure envelope. [6]

b. Draw neatly the following qualitative curves:

(i) Volume change versus axial strain for saturated samples of loose sand and dense sand in consolidated drained (CD) direct shear tests.

(ii) Pore pressure versus axial strain for saturated sample of heavily overconsolidated clays in consolidated (with back pressure) undrained triaxial compression test. [3]

c. 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 20 N-m. The values of liquid limit and plastic limit of the clay are 62 and 21, respectively. Assuming uniform mobilization of end shear, calculate the design value of undrained shear strength of the clay? [4]

d. A smooth vertical wall of height 10 m retains a soft clay backfill of unit weight 16 $kN/m^3$. Undrained shear strength of the clay backfill is 30 $kN/m^2$. For undrained condition ($\phi_u = 0$) of the soft clay backfill, calculate the following:

(i) Unsupported height of the wall

(ii) Active earth force before tension crack forms

(iii) Active earth force after tension crack forms

Also draw the active pressure diagram. [4]

e. Explain the concept of passive earth pressure.

For the retaining wall shown in Figure 1, water table is located at the existing ground level (EGL). Draw active pressure diagrams due to backfill ($\gamma_{sat}$ = 20 $kN/m^3$, $c'$= 5 $kN/m^2$ and $\phi'$= 30°), surcharge (30 $kN/m^2$) and ground water separately. Also determine the total active force per metre length of the wall. [8]

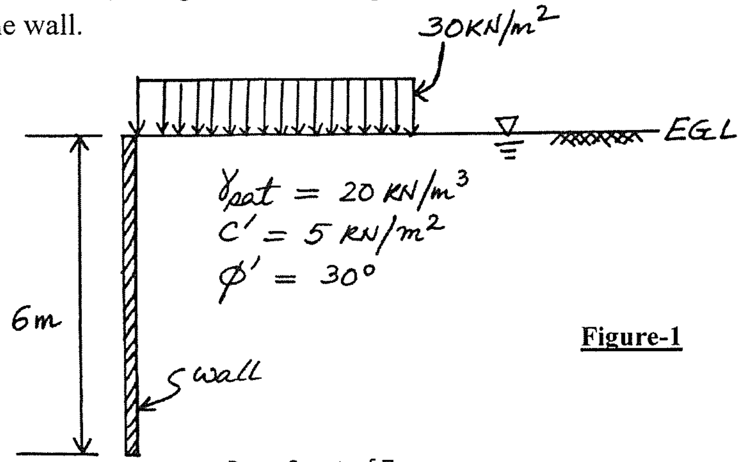



**Figure-1**

## PART-B [75 MARKS]

### QUESTION 4 [25 MARKS]

The Following figures showing the Raft foundation of a multy-storied building. Dimensions are shown in Figure-2. The Raft is experiencing 5 ksf uniform vertical stress at base level. Investigations has confirmed that a weak soil zone lies at a depth of 15 ft from existing ground level at the center point(P) of the Raft. Now calculate the vertical stress at that point caused by the Raft loading. Use Newmark Influence Chart Method. [25]

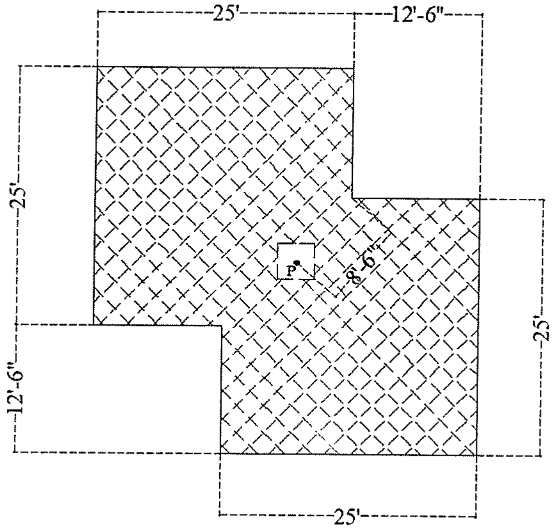



Figure-2

### QUESTION 5 [30 MARKS]

a. Using a neat, qualitative sketch, explain the procedure for plotting the Virgin Consolidation Curve from the Laboratory Consolidation Curve for over consolidated (OC) clay. Based on this curve, clearly define the term Compression Index and Swell Index. [5]

b. A footing is placed on a sandy layer underlying successive sand and clay strata with properties shown in Figure-3.

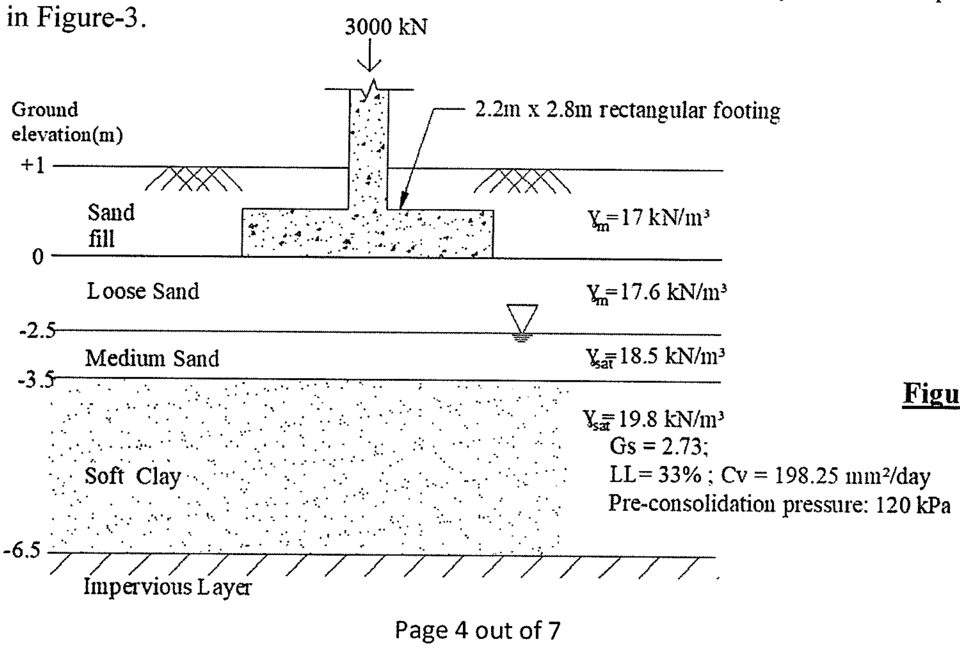



Figure-3

Calculate the followings: [10+5+5+5=25]

i. Primary consolidation settlement of the soft clay layer.
ii. Time required for 25mm settlement.
iii. Settlement after 25 years.
iv. Calculate the required footing dimension(square) to control the settlement to 12.5mm after 50 years.

**QUESTION 6 [20 MARKS]**

a. The following figure(figure-4) shows an embankment of a road. Find the stress at point "D" which is in 3m depth below the center of the cross section of the embankment. [14]

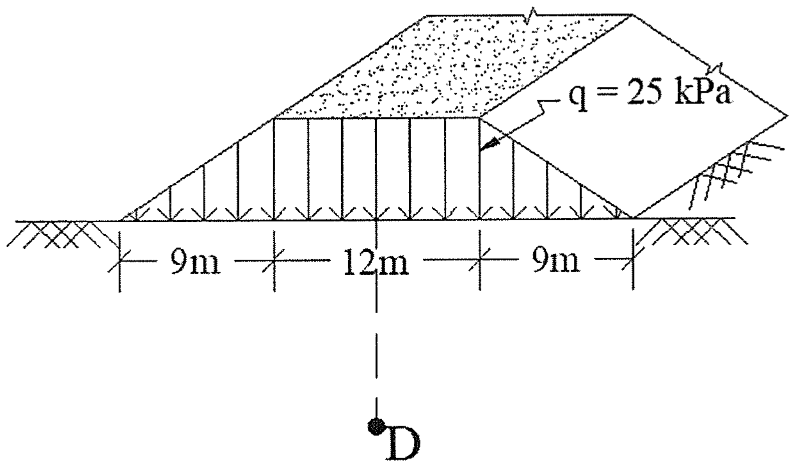



**Figure-4**

b. The following figure (Figure-5) shows a soil profile with different layer properties. Calculate the total stress, pore water pressure and effective stress at point A, B and C. [6]

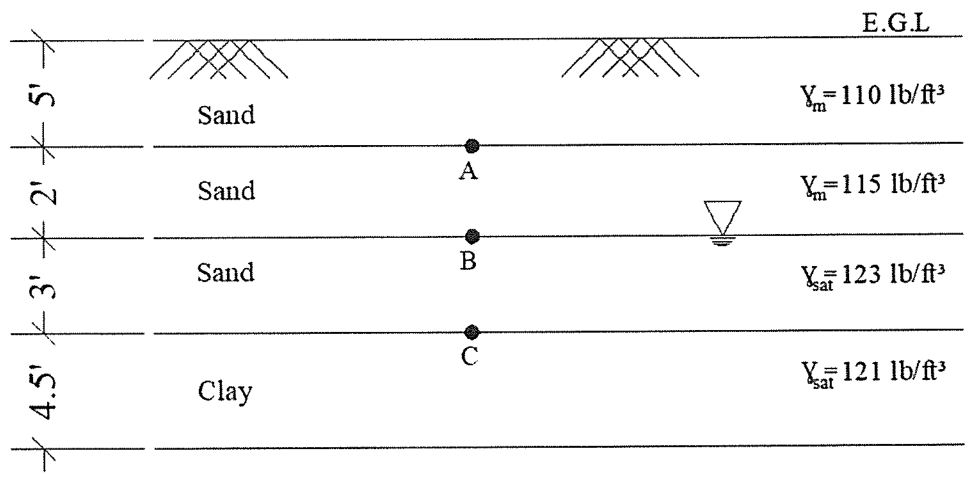



**Figure-5**

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

Reduction factor (For Field Vane Shear Test), **$\lambda$ = 1.7 – 0.54 $\log_{10}$ PI**

- vertical stress at a particular depth below the surface of a uniformly loaded area of rectangular shape:

$$\sigma_z = \frac{q}{\pi}[\alpha + \sin\alpha \cos(\alpha + 2\beta)]$$

- vertical stress at a particular depth below the surface of a uniformly loaded area of triangular shape:

$$\sigma_z = \frac{q}{2\pi}[\frac{2x}{B}\alpha - \sin 2\delta]$$

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

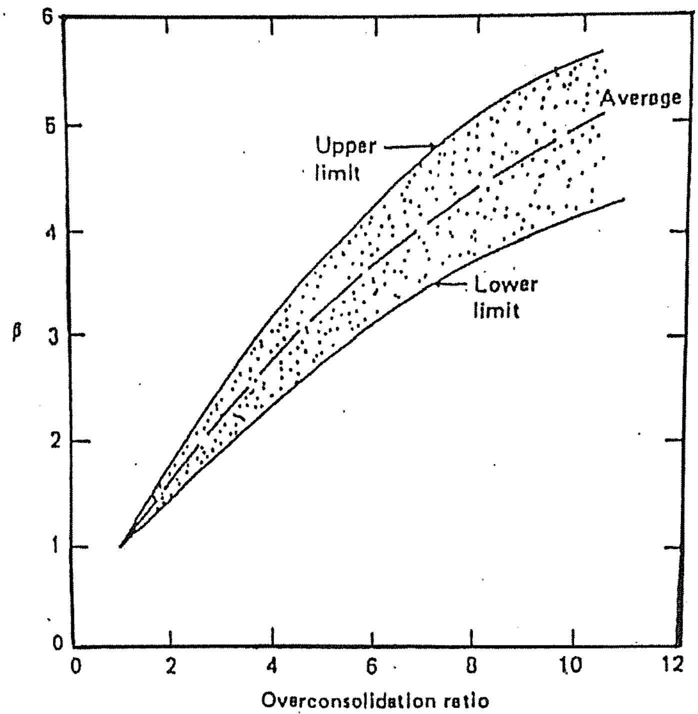
$$\sigma_z = q[1 - \frac{1}{\{1+\left(\frac{a}{z}\right)^2\}^{3/2}}]$$

- Time Factor:
  For U≤60%; $T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$
  For U>60%; Tv= 1.781-0.933$\log_{10}$(100-U%)

## 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<br>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.




## Chart 2 Plot of β versus Overconsolidation Ratio

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination, Spring 2025
# Program: B.Sc. in Civil Engineering
# 3rd Year 1st Semester

Course Title: Geotechnical Engineering I (Old) Course Code: CE 341 (Old)
Time: 3 hours Credit Hour: 3.00 Full Marks: 100

**Answer all the questions. Assume any missing value.**

## QUESTION 1 [15 MARKS]

Classification tests were done on an inorganic soil sample and the following results were obtained:

| Sieve | Percent Finer (%) |
|---|---|
| No. 4 sieve (4.75 mm) | 97 |
| No. 10 sieve (2 mm) | 55 |
| No. 40 sieve (0.425 mm) | 35 |
| No. 200 sieve (0.075 mm) | 8 |

**Consistency test results of soil fraction finer than No. 200 sieve (0.075 mm):**

- Liquid limit (LL) = 40%
- Plastic limit (PL) = 20%

**From grain size data:**

$D_{10}$ = 0.065 mm; $D_{30}$ = 0.525 mm; $D_{60}$ = 2.2 mm. Classify the soil using the **Unified Soil Classification System (USCS).**

## QUESTION 2 [15 MARKS]

Classify the following soil samples according to **AASHTO Soil Classification system.** AASHTO Soil Classification Chart is provided

| | Soil Sample | | | | |
|---|---|---|---|---|---|
| **Description** | **A** | **B** | **C** | **D** | **E** |
| Percent Finer than No 10 Sieve | 100 | 100 | 20 | 90 | 100 |
| Percent Finer than No 40 Sieve | 99 | 92 | 10 | 76 | 82 |
| Percent Finer than No 200 Sieve | 75 | 86 | 2 | 34 | 38 |
| Liquid Limit, **LL** | 110 | 70 | - | 37 | 42 |
| Plasticity Index, **PI** | 50 | 32 | 3 | 12 | 23 |

## QUESTION 3 [10 MARKS]

The moist weight of **0.18 ft³** of a soil is **24 lb**.
The **moisture content** and **specific gravity of soil solids** are determined in the laboratory to be **15%** and **2.8**, respectively. **Calculate the following:**

a. Moist unit weight (lb/ft³)
b. Dry unit weight (lb/ft³)

c. Void ratio
d. Porosity
e. Degree of saturation (%)

**For this soil** $e_{max} = 0.82$, $e_{min} = 0.42$, Find out the **relative density (Dr)**.

$$\gamma = \frac{W}{V} \quad \gamma_d = \frac{\gamma}{1+w} \quad e = \frac{G_s \gamma_w}{\gamma_d} - 1 \quad n = \frac{e}{1+e} \quad S = \frac{w G_s}{e} \quad D_r = \frac{e_{max} - e}{e_{max} - e_{min}}$$

## QUESTION 4 [5 MARKS]

The maximum and minimum dry unit weights of a sand were determined in the laboratory to be 19 and 15 kN/m$^3$, respectively. What is the relative compaction in the field if the relative density is 60%?

$$D_r = \frac{\gamma_{df} - \gamma_{d\,min}}{\gamma_{d\,max} - \gamma_{d\,min}} \frac{\gamma_{d\,max}}{\gamma_{df}} \quad R = \frac{\gamma_{df}}{\gamma_{d\,max}}$$

## QUESTION 5 [20 MARKS]

A point load of magnitude 250 kN acts on the surface of the ground. Assuming the soil mass to be uniform, compute the intensity of vertical stress due to the load at depths of 0 m, 1 m, 5 m, 10 m, 50 m, and 100 m:

**a.** along the vertical line of action of the point load.

**b.** along the vertical line having a horizontal distance of 5 m from the line of action of the load

**c.** find the vertical stress along a horizontal plane at a depth of 1 m from the ground level at radial distances of 0, 0.25 m, 0.5 m, 0.75 m, 1.0 m, and 2.0 m from the line of action of the load.

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

## QUESTION 6 [10 MARKS]

Define Quick condition of soil. Explain the effects of Quick condition of soil.
A stratum consisting of fine sand is 4 m thick. Under what head of water, flowing in an upward direction, will a quick sand condition develop? Take specific gravity of solids and void ratio as 2.50 and 0.90, respectively.

$$i_c = \frac{G-1}{1+e}$$

## QUESTION 7 [15 MARKS]

If a uniformly distributed load, Δp is applied at the ground surface, what is the **settlement** of the clay layer caused by primary consolidation if

a. The clay is normally consolidated
b. The pre-consolidation pressure, $p_c = 220$ kN/m²
c. $p_c = 180$ kN/m²
Use $Cs \approx \frac{1}{6}Cc$.

- $\Delta p = 60$ kN/m²
- The 1st sand layer is 4 m thick ($\gamma_{dry}$=15kN/m³)
- The second sand layer is 5 m thick ($\gamma_{sat}$=19 kN/m³)
- The third layer of clay is 8 m thick ($\gamma_{sat}$= 18kN/m³)
- void ratio e =1.1 Liquid limit, LL=55

**For NC Clay, Settlement** $\Delta H = \frac{H.C_c}{1+e_0}\log\frac{p'_1}{p'_0} = \frac{H.C_c}{1+e_0}\log\frac{p'_0+\Delta p}{p'_0}$

OC clay and $p'_1 \le p'_c$ or $p'_0+\Delta p \le p'_c$ **Settlement,** $S = \frac{H.C_r}{1+e_0}\log\frac{p'_1}{p'_0} = \frac{H.C_r}{1+e_0}\log\frac{p'_0+\Delta p}{p'_0}$

OC clay and $p'_1 > p'_c$ or $p'_0+\Delta p > p'_c$ **Settlement,** $S = \frac{H.C_r}{1+e_0}\log\frac{p'_c}{p'_0} + \frac{H.C_c}{1+e_c}\log\frac{p'_1}{p'_c}$

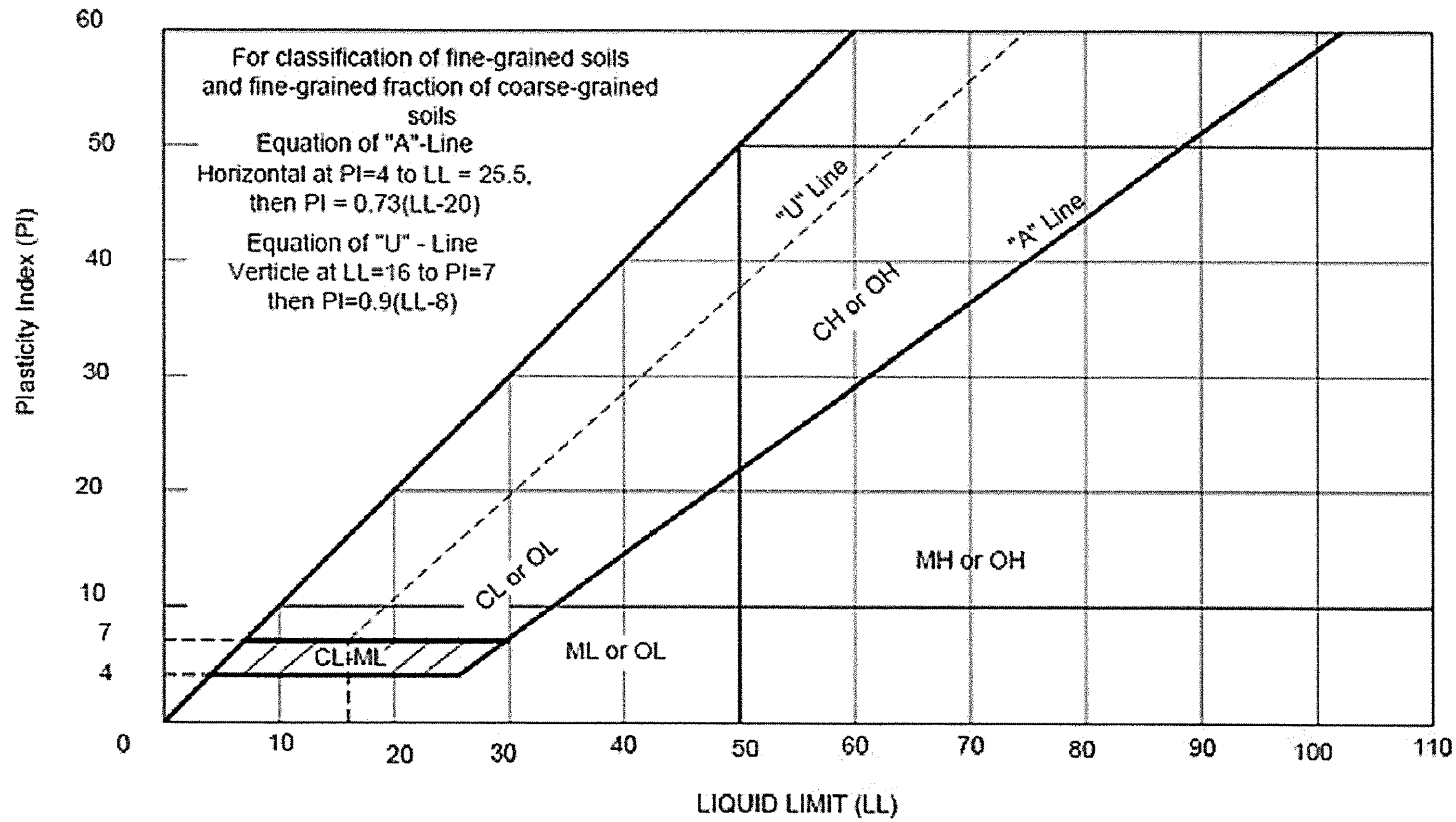
**QUESTION 8 [10 MARKS]**

Consolidated drained (CD) direct shear tests were conducted on three specimens of a silty clay sample. Initial height and diameter of the specimens were 25.4 mm and 63.5 mm, respectively. The following results were obtained at failure:

| Normal load (kg) | Peak shear load (kN) |
|---|---|
| 30 | 240 |
| 60 | 470 |
| 120 | 950 |

Draw the failure envelope on a plain graph paper and hence estimate the values of the effective shear strength parameters (**c′** and **Ø′**) of the given soil sample. Also, comment on the stress history of the sample.

# Unified Soil Classification System (USCS)




## Plasticity Chart

9

# Unified Soil Classification System (USCS)

| Soil Classification Chart (ASTM D2487) Criteria for Assigning Group Symbols and Group Names using Laboratory Tests [A] | | | | Soil Classification | |
|---|---|---|---|---|---|
| | | | | Group Symbol | Group Name [B] |
| COARSE GRAINED SOILS; More than 50% retained on No. 200 sieve | Gravels; More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels; Less than 5% fines [C] | $C_u \geq 4$ and $1 \leq C_c \leq 3$ [E] | GW | Well graded gravel [F] |
| | | | $C_u < 4$ and/or $1 > C_c > 3$ [E] | GP | Poorly graded gravel [F] |
| | | Gravels with Fines; More than 12% fines [C] | Fines classify as ML or MH | GM | Silty gravel [F, G, H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel [F, G, H] |
| | Sands; 50% or more of coarse fraction passing No. 4 sieve | Clean Sands; Less than 5% fines [D] | $C_u \geq 6$ and $1 \leq C_c \leq 3$ [E] | SW | Well graded sand [I] |
| | | | $C_u < 6$ and/or $1 > C_c > 3$ [E] | SP | Poorly graded sand [I] |
| | | Sands with Fines; More than 12% fines [D] | Fines classify as ML or MH | SM | Silty sand [G, H, I] |
| | | | Fines classify as CL or CH | SC | Clayey sand [G, H, I] |
| FINE GRAINED SOILS; 50% or more passing No. 200 sieve | Silts and clays; Liquid limit less than 50 Low Plasticity | Inorganic | PI > 7 and plots on or above "A"-line | CL | Lean clay [K, L, M] |
| | | | PI < 4 or plots below "A"-line | ML | Silt [K, L, M] |
| | | Organic | $\frac{\text{Liquid Limit} - \text{Oven dried}}{\text{Liquid Limit} - \text{Not dried}} < 0.75$ | OL | Organic clay [K, L, M, N] |
| | | | | OL | Organic silt [K, L, M, O] |
| | Silts and clays; Liquid limit 50 or more High Plasticity | Inorganic | PI plots on or above "A"-line | CH | Fat clay [K, L, M] |
| | | | PI plots below "A"-line | MH | Plastic silt [K, L, M] |
| | | Organic | $\frac{\text{Liquid Limit} - \text{Oven dried}}{\text{Liquid Limit} - \text{Not dried}} < 0.75$ | OH | Organic clay [K, L, M, P] |
| | | | | OH | Organic silt [K, L, M, Q] |
| HIGHLY ORGANIC SOILS | | Primarily organic matter, dark in colour, and organic odour | | PT | Peat |

[A] Based on the material passing the 3-in (75 mm) sieve.
[B] If field sample contains cobbles or boulders, or both, add "with cobbles and boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual classification.
GW-GM well graded gravel with silt
GW-GC well graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12% fines require dual classification
SW-SM well graded sand with silt
SW-SC well graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with silt

[E] $C_u = \frac{D_{60}}{D_{10}}$; $C_c$ or $C_z = \frac{(D_{30})^2}{D_{60} \times D_{10}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[H] If fines are organic, add "with organic fines" to group name
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name
[J] If Atterberg limits plot in hatched area, soil is a CL-ML silty clay

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant
[L] If soil contains ≥ 30% plus No. 200, and predominantly sand add "sandy"
[M] If soil contains ≥ 30% plus No. 200, and predominantly gravel add "gravelly"
[N] PI ≥ 4 and plots on or above "A"-line
[O] PI < 4 and plots below "A"-line
[P] PI plots on or above "A"-line
[Q] PI plots below "A"-line

# AASHTO Soil Classification Chart

| 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<br>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.

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

# University of Asia Pacific
# Department of Civil Engineering
# Final Examination, Spring 2025

## Program: B.Sc. in Civil Engineering
## 3rd Year 1st Semester

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

**Answer all the questions**

**QUESTION 1 [13 MARKS]**

a. Classify open channel based on slope and bed material. Discuss them briefly. [5]

b. For a gradual flood condition, consider fall of water surface F. With the aid of a figure, applying energy equation at a segment of a river, derive an expression for calculating energy loss ($h_f$) under the scope of **Slope Area Method**. [5]

c. Write down three key considerations for the design of an open channel flow [3]

**QUESTION 2 [10 MARKS]**

a. Derive the expression for the normal force when a jet of water strikes a stationary flat plate. [5]

b. Derive the expression for critical depth in terms of energy coefficient, discharge and side slope for a triangular channel using the equation of section factor. [5]

**QUESTION 3 [17 MARKS]**

a. A spillway flip bucket has a radius of curvature of 25 m. If the flow depth is 3 m and discharge per unit with is 15 $m^2/s$, determine the pressure at the bottom of the concave plane. [5]

b. Derive an expression for equivalent Manning's roughness coefficient (n) for a rectangular channel considering the following roughness properties: [6]
   - Manning's roughness co-efficient of the bottom material = $n_1$
   - Manning's roughness co-efficient of the left-bank material = $n_2$
   - Manning's roughness co-efficient of the right-bank material = $n_3$

c. Determine the geometric parameters A, P, R, B and D of a best hydraulic rectangular section. [6]

**QUESTION 4 [10 MARKS]**

Water flows at a velocity of 1.25 m/s and a depth of 1.75 m in long rectangular channel 3 m wide. Determine the height of a smooth upward step to produce critical flow and the change in water level produced by the step. Neglect energy loss and take $\alpha$=1. [10]

**QUESTION 5 [15 MARKS]**

Water flows at a velocity of 7 m/s and a depth of 0.8 m in a horizontal rectangular channel 6 m wide. Find: **(i)** Type of jump, **(ii)** the downstream depth necessary to form the jump, **(iii)** the downstream Froude number, **(iv)** the length of the jump, **(v)** the height of the jump, **(vi)** the efficiency of the jump, **(vii)** the energy loss in the jump, and **(viii)** the power dissipation in the jump. [15]

**QUESTION 6 [15 MARKS]**

For a trapezoidal channel with b = 8 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 Newton-Raphson method. Show the first two trials. [15]

**QUESTION 7 [20 MARKS] CO2/PO3/C5**

An irrigation canal has to carry a discharge of 60 $m^3/s$ through a non-cohesive slightly rounded coarse material having $d_{50}$=19.05 mm, $d_{75}$=2.29 cm. The canal is to be trapezoidal in shape and laid on a longitudinal slope of 1 in 2000. Design the channel using the method of Lane. [20]