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Faculty of Engineering & Technology
Department of Civil Engineering
BSc. Hons. (Eng.) in Civil Engineering
Semester 4 First Sit - Final Examination 2026
Batch : 07

Module Code: CE2325	**Module Title: Soil Mechanics & Engineering Geology I**
Date: 08/06/2026	**Duration: 03 hours**
Examiner : Supun Walpita	

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper consists of three questions and 9 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets and graph papers for your answers. You may use a scientific calculator.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- *Start each question on a new page in the answer booklet, answer sheets. Clearly indicate the question number at the top of the page.*
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*

Q1 **i)** Describe How particle size and particle size distribution affects the engineering properties of soil such as permeability, compaction [04]

ii) Observations of a sieve analysis test is shown below in **Table 1.**

Table 1

Sieve size (mm)	Mass retained (g)
5	62
2.36	83
1.18	112
0.6	50
0.3	44
0.075	23
pan	33

a) Plot the particle size distribution curve [12]

b) Determine sand, gravel and fine fractions [03]

c) Determine the coefficient of uniformity (C_u) and coefficient of curvature (C_c) of the soil [02]

d) Determine whether the soil is well graded or poorly graded based on C_u and C_u values [02]

iii) Results of liquid and plastic limit tests of the fine fraction is shown in **Table 2**.

Table 2

	Liquid limit test				Plastic limit Test	
	Test 01	Test 02	Test 03	Test 04	Test 01	Test 02
Container +Wet soil (g)	33.20	32.10	28.20	31.00	11.83	15.04
Container +Dry soil (g)	28.20	26.50	22.40	23.90	11.25	14.07
Container (g)	7.02	7.04	7.10	7.02	7.04	7.25
No of blows	34	31	27	23	–	–

a) Determine the Liquid limit, Plastic Limit and plasticity index of the soil [10]

b) Comment on the plasticity of the soil using above indices [03]

c) Classify the soil using Unified soil classification system [04]

Total [40]

Q2. i) Briefly Discuss the differences of aeration zone and saturation zone in terms of subsurface water flow. [04]

ii) Suppose that you are required to accurately determine the coefficient of permeability of two different soils. By earlier inspections, it was approximately found that the coefficient of permeability of two different soils are around 10^{-2}m/s and 10^{-6} m/s respectively. Explain which laboratory tests (constant head or falling head) you will recommend for each soil by giving valid reasons. [06]

iii) A system of three soil layers overlies an impermeable bedrock as shown in **Figure 1**.

a) Find the average permeability (k_y) for the whole deposit when the flow is perpendicular to bedding planes. [04]

b) Find the average permeability (k_x) for the whole deposit when the flow is parallel to bedding planes. [04]

c) Suppose the permeability of the fine sand layer is increased by 10 times by replacing it with a coarse sand layer. Without performing calculations, determine whether the k_x or t k_y will be most affected. Justify your answer with valid reasons. [04]

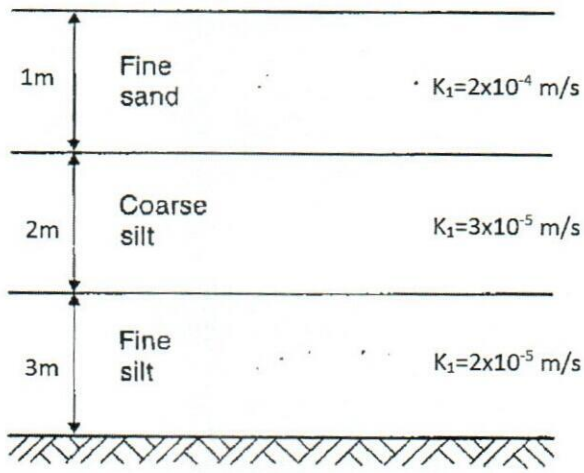


Figure 1

iv) A pumping test was carried out in a soil deposit of thickness 15 m overlaying an impermeable bedrock. Rate of pumping was $10.6 \times 10^{-3} m^3/s$. Observation wells located at 15 m and 30 m from the center of the pumping well. The water levels of two wells were recorded as 1.6 m and 1.4 m, respectively, from the initial groundwater level. The initial groundwater level was located at 1.9 m below ground surface level. Determine the average permeability of the soil deposit. [06]

Total [28]

Q3. i)

a) Illustrate the rock cycle. [03]

b) Discuss the processes of physical and chemical weathering of rocks. Explain how different environmental conditions influence the rate and type of weathering. [04]

c) Explain the terms "transported soil" and "residual soil" [04]

ii)

a) Describe the purpose of conducting Laboratory compaction [03]

iii) The results of a laboratory proctor compaction test results for a coarse grained soil is shown in **Table 3**. The volume and mass of the proctor mould are $1000 cm^3$ and 4.5kg respectively (Assume $g = 10 ms^{-2}$).

Table 3

Moisture content%	Mass of wet soil in the mould (kg)
6	6.16
8	6.34
10	6.55
12	6.44
14	6.21

Following are the results obtained from a field unit-weight determination test performed on the same soil by means of the sand cone method:

Calibrated dry density of Ottawa sand = $1600 kg/m^3$
Calibrated mass of Ottawa sand to fill the cone = 0.550 kg
Mass of jar + cone + sand (before use) = 7.49kg
Mass of jar + cone + sand (after use) = 4.65 kg
Mass of moist soil from hole = 2.890 kg
Moisture content of moist soil = 11%

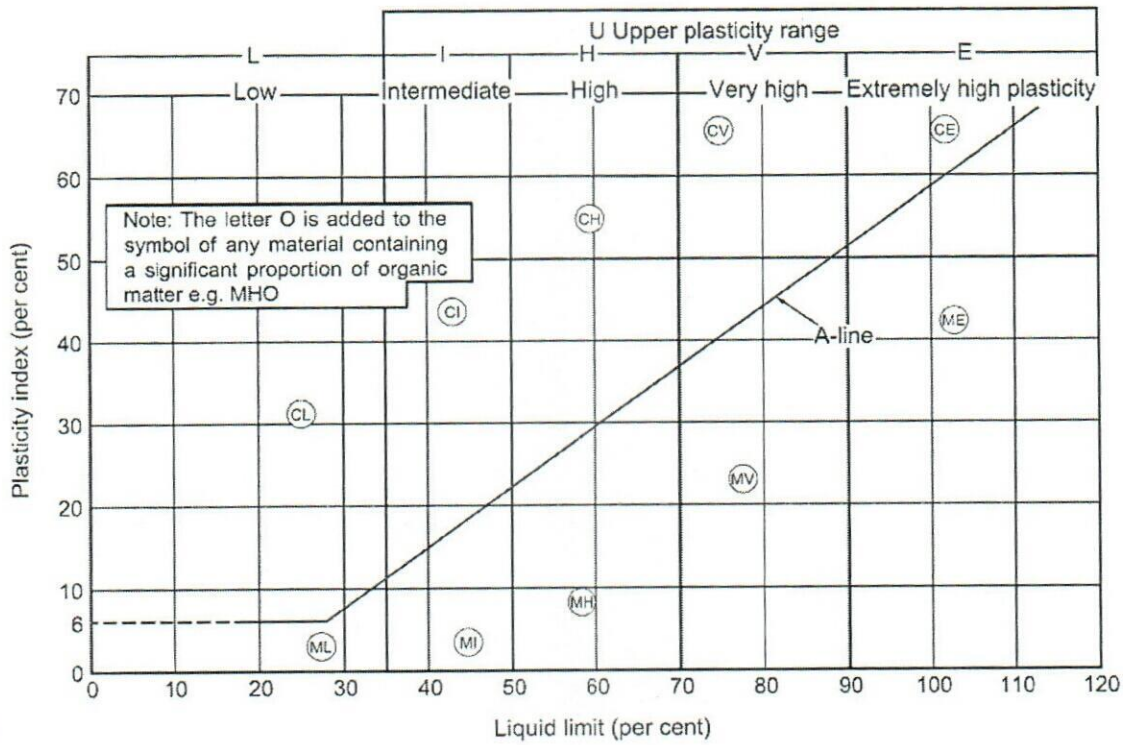
a) Calculate Field Dry unit weight [07]

b) Draw a compaction curve and estimate the maximum laboratory dry unit weight [09]

c) Determine Relative compaction in the field [02]

Total [32]

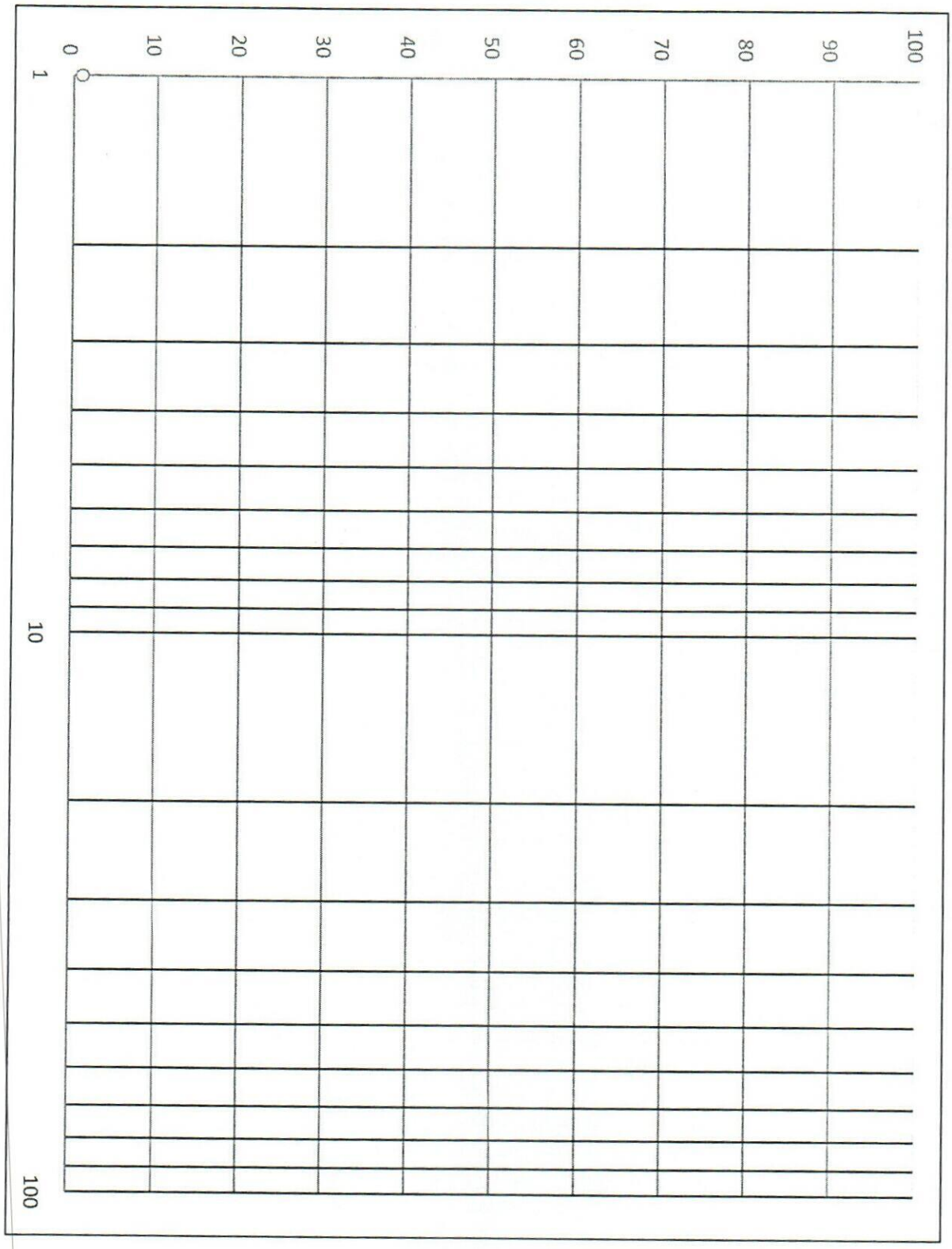
Supplementary Information



$$k = \frac{1}{H}(k_1H_1 + k_2H_2 + k_3H_3 + \cdots + k_nH_n)$$

$$k = \frac{H}{\left(\frac{H_1}{k_1}\right) + \left(\frac{H_2}{k_2}\right) + \left(\frac{H_3}{k_3}\right) + \cdots + \left(\frac{H_n}{k_n}\right)}$$

$$k = \frac{q \ln r_2/r_1}{\pi(h_2^2 - h_1^2)} \qquad k = \frac{al}{At} ln \frac{h_1}{h_2}$$


0
10
20
30
40
50
60
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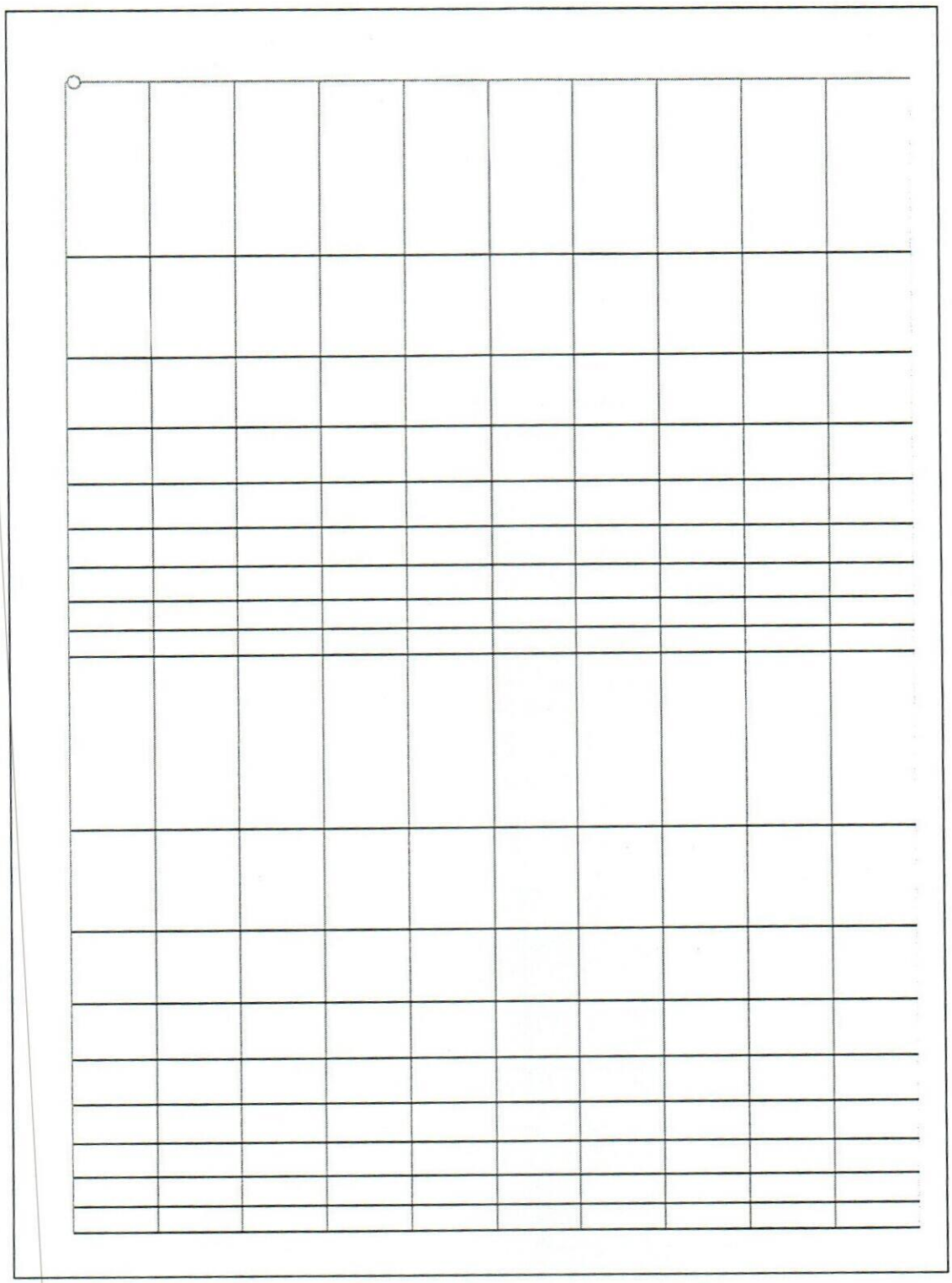
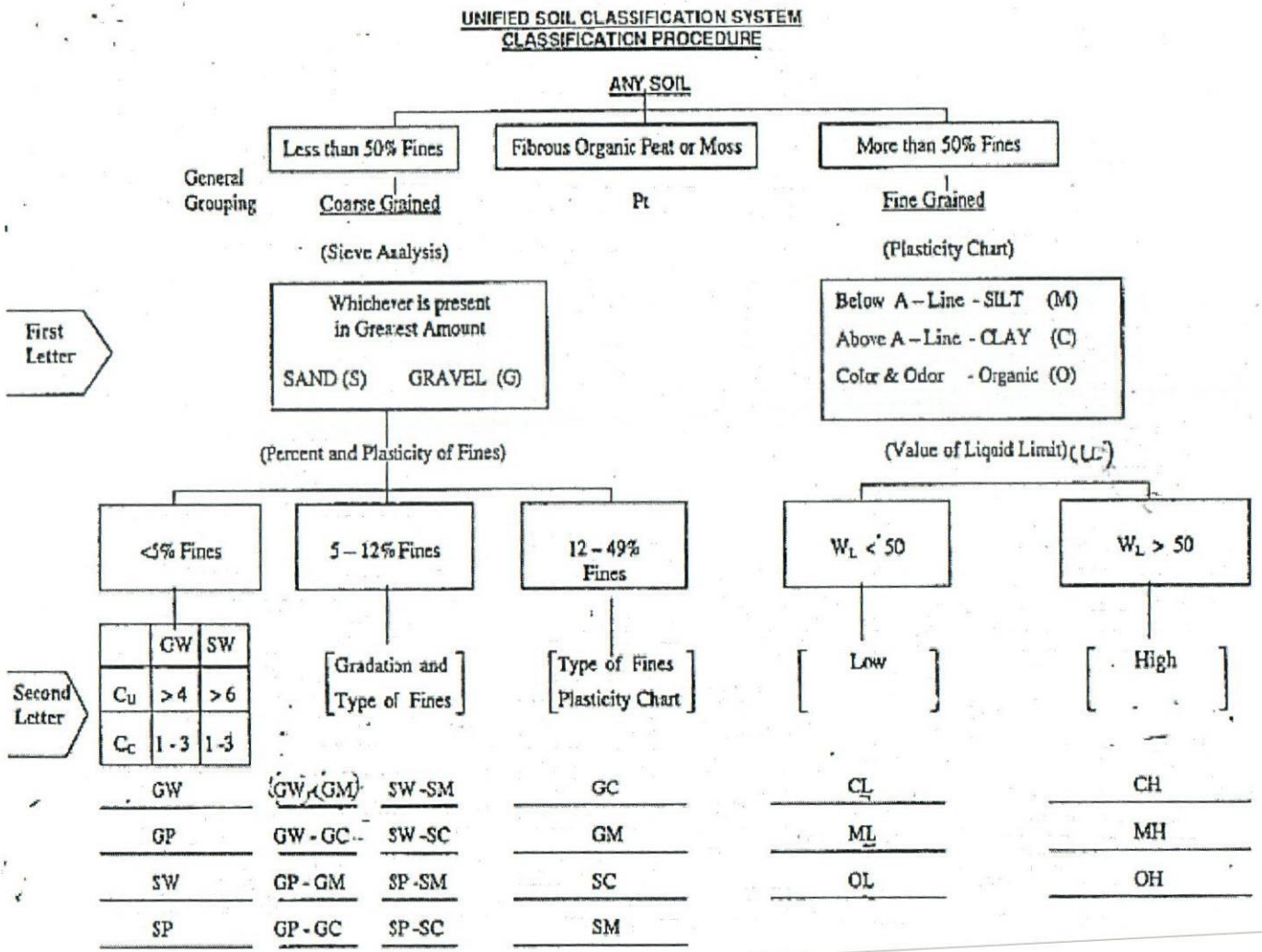
100




UNIFIED SOIL CLASSIFICATION SYSTEM
CLASSIFICATION PROCEDURE
ANY SOIL
Less than 50% Fines
Fibrous Organic Peat or Moss
More than 50% Fines
General Grouping
Coarse Grained
Pt
Fine Grained
(Sieve Analysis)
(Plasticity Chart)
First Letter
Whichever is present in Greatest Amount
SAND (S) GRAVEL (G)
Below A – Line - SILT (M)
Above A – Line - CLAY (C)
Color & Odor - Organic (O)
(Percent and Plasticity of Fines)
(Value of Liquid Limit) (W_L)
<5% Fines
5 – 12% Fines
12 – 49% Fines
W_L < 50
W_L > 50
Second Letter
GW
SW
C_U
>4
>6
C_C
1 - 3
1 - 3
[Gradation and Type of Fines]
[Type of Fines Plasticity Chart]
[Low]
[High]
GW
GP
SW
SP
GW - GM
GW - GC
GP - GM
GP - GC
SW - SM
SW - SC
SP - SM
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Faculty of Engineering & Technology Department of Civil Engineering BSc. Hons. (Eng.) in Civil Engineering Semester 4 Final Examination 2026 Batch: 07	
Module Code: CE2326	**Module Title: Surveying I**
Date: 4th June 2026	**Duration: 3 hrs**
Examiner:	**Mr. Umal Fernando**

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed.*
- *This paper consists of four 04 questions and 6 pages. Answer all questions.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
- *Write clearly and legibly. Use a blue or black pen only.*
- *Write your student number on all sheets.*
- ***Start each question on a new page** in the answer booklet, answer sheets. **Clearly indicate the question number at the top of the page.***
- *If parts of the same question are written discontinuously in non-consecutive sheets, ensure that each part is relevantly labelled with its corresponding question number.*
- *If any data is missing, reasonable assumptions may be made; however, all such assumptions must be clearly stated in the answer script.*

Q1 **i)** Explain the importance of Engineering Surveying in different phases in a construction project. [03]

ii) Classify surveying according to the purpose of surveying. [04]

iii) a) Simply explain the following steps with regards to tape and offset surveying.

- Reconnaissance Survey
- Drawing Prospection diagram
- Taking Tie measurements
- Taking the Bearing of the line

[08]

b) A survey line was measured in four spans using a steel band suspended freely from its ends, by applying a pull through a spring balance. The observations made at a temperature of 29.5 °C are shown in Table 1. The steel band was found to be 30.005 m long between its end marks when checked on a flat surface at a temperature of 20 °C and at a pull of 100 N. Find the true length of the survey line using the following physical properties of the steel band. **Refer Table 1.**

- Mass of the band = 0.025 kg/m
- Cross section area of the band = 3.15 mm^2
- Elastic modulus of steel = 210 kN/mm^2
- Coefficient of linear expansion of steel = 1.15 x 10^{-5} per °C
- 1 kgf = 9.81 N

$$L' = L \times \frac{measured\ length}{assumed\ length}, C_{temp} = KL(t - t_s), C_{Tension} = \frac{(T - T_s)L}{AE}$$

$$C_{sag} = \frac{W^2L^3}{24P^2}, C_{slope} = \frac{h^2}{2L}$$

[10]

Total [25]

Q2. **i)** Briefly define following terms in leveling work.

- Level surface and horizontal surface
- Back sight and fore sight
- Datum and reduced level

[06]

ii) Levelling work was done between two known points namely TBM 'A' and TBM 'B'. Refer **Table 2 in page 06** for the level sheet with the observed readings during the levelling exercise. You may answer the following questions in the table itself as necessary, and then detach the paper and attach it to your answer script.

a) Calculate the reduced levels using either Rise and Fall method or Height of Collimation method. [08]

b) Perform relevant arithmetic checks. [02]

c) Calculate the error in the levelling work and compare it with the allowable error. (Take least count of levelling staff as 5 mm) (Allowable error = $\pm d\sqrt{N}$ mm where d is the smallest reading interval in the levelling staff, N is the No. of instrument stations.) [02]

d) If the error is less than the allowable range, calculate the corrected reduced levels. [04]

iii) Differentiate between Rise and Fall method and Height of Collimation method with regards to their associated pros and cons. [03]

Total [25]

Q3. i) Total Station is a modern surveying instrument used to perform accurate angle and distance measurements.

a) Briefly explain the three major components of a Total Station and describe the function of each component. [03]

b) Before making observations, certain temporary adjustments must be carried out. Describe the procedure for the following adjustments:

- Centering
- Focusing

[04]

c) A survey team starts taking measurements without properly carrying out the temporary adjustments of the Total Station. Discuss the possible errors that may occur and explain how these errors could affect the accuracy of the survey results. [03]

ii) **Table 3** shows the lengths of the sides and the whole circle bearings of the lines, measured in a closed anticlockwise traverse ABCDEF.

a) Check angular observations and adjust any angular misclosure. [02]

b) Check whether there is a closing error resulting from linear measurements (after the angular misclosure) and adjust it. [06]

c) Calculate the corrected coordinate values of each control point. (Take the values 1000.00 mN and 2000.00 mE for point A) [05]

iii) Define the term retroreflection in the context of EDM reflectors. Explain why this property is crucial for accurate distance measurement. [02]

Total [25]

Q4. i) a) Area and volume calculations are fundamental in surveying and civil engineering. Discuss their significance in the successful execution of civil engineering projects. [02]

b) **Table 4** shows the coordinates for the closed traverse ABCDEA using the total station. Find the area enclosed by the polygon. [05]

c) **Table 5** shows the perpendicular offsets taken from chain line at following intervals to an irregular boundary in the given order. Calculate the area enclosed between the survey lines by trapezoidal and Sympson's rule.

Simpson's Rule:

$$Total\ area = \frac{d}{3}(h_1 + 4\sum evenofsets + 2\sum Oddoffsets + h_n)$$ [07]

d) Briefly explain the concept of a mass haul diagram and discuss how it is used in the optimization of earthwork operations in civil engineering projects. [04]

ii) Setting out is the process of establishing the position and level of proposed structures on the ground according to design drawings.

a) What problems might arise during construction if setting out is carried out inaccurately? Give examples. [03]

b) Briefly explain the following terms used in setting out procedures:

- Profile boards
- Building line
- Reference pegs
- Centre line

[04]

Total [25]

Table 01:

Span	Measured Length (m)	Applied pull **(kgf)**	Level difference between ends (m)
01	29.830	15.0	0
02	29.685	15.0	0.250
03	29.960	12.0	0.374
04	20.720	12.0	0.236

Table 03:

Line	Whole circle bearing			Length (m)
	o	'	"	
AB	302	25	14	42.210
BC	286	17	23	24.389
CD	214	57	00	44.571
DE	155	21	55	39.915
EF	101	13	52	33.206
FA	35	22	02	61.064

Table 04:

Point	E (m)	N (m)
A	364.392	674.345
B	526.937	715.825
C	682.910	562.826
D	561.039	328.426
E	385.491	351.813

Table 05:

Chainage	0	10	20	30	40	60	80	95	110	125
Offset	6.52	7.63	8.69	10.44	9.87	6.55	7.93	8.49	9.66	10.45

Table 02:

Back Sight	Inter. Sight	Fore Sight						Remarks
1.361								TBM 'A' 120.842 MSL
	2.844							
	2.018							
0.855		3.015						CP
	0.611							
2.741		1.805						CP
2.855		1.711						CP
	1.362							
	2.111							
	0.856							
		2.015						TBM 'B' 120.100

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Faculty of Engineering & Technology Department of Civil Engineering BSc. Hons. (Eng.) in Civil Engineering Semester 4 First Sit - Final Examination 2026 Batch: B. Sc. Batch 7	
Module Code: CE 2324	**Module Title: Hydrology**
Date: 02nd June 2026	**Duration: 3 hrs**
Examiner:	**Dr. H.G. Shanka Maduranga**

Instructions to Candidates:

- *This is a closed book examination. No reference materials are allowed unless specified.*
- *This paper contains two (2) sections titled as Section A and Section B in five (5) pages.*
- *Section A contains a compulsory short answer and essay-type question.*
- *Section B contains three (3) short answer and essay-type questions.*
- *Answer all questions in Section A and answer only two (2) questions from Section B.*
- *The marks allocated to each question are listed in the column on the far right. Final mark of the question paper will be calculated out of 100.*
- *Use only the provided answer booklet, additional sheets, and graph papers for your answers.*
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SECTION A

Section A is compulsory. Answer all questions.

Q1 Hydrology is the study of the distribution and movement of water both on and below the Earth's surface. It evaluates the impact of human activity on water availability and water quality. (National Geographic's Society, 2026)

i) Briefly describe the applications of hydrology in Civil Engineering. [05]

ii) Draw hydrological cycle and demarcate at least four (4) hydrological processes involved in movement of water. [04]

iii) A small catchment of 150 ha area received a rainfall of 10.5 cm in 90 minutes due to a storm. At the outlet of the catchment, the stream draining the catchment was dry before the storm and experienced a runoff lasting for 10 hours with an average discharge of 1.5 m3/s. The stream was again dry after the runoff event.

a) What is a catchment? [02]

b) Write the water balance equation for a catchment. [02]

c) By using above (b) equation, estimate total water loss for the above (iii) hydrological event. [04]

d) Calculate the runoff coefficient for the above (c) scenario. [02]

e) State three (3) hydrological processes which could cause above (c) water losses. [03]

iv) Evapotranspiration is considered as one of the most important component of water movement from lithosphere to atmosphere.

a) What is evapotranspiration? [02]

b) Write six (6) factors affecting the rate of transpiration. [03]

c) Define saturation, field capacity and wilting point of a soil layer using a diagram. [04]

v) Describe two types of infiltrometers with diagrams which used to measure field infiltration rate and specify the limitations and accuracy of each. [04]

vi) Groundwater originates from rain or snow infiltrating the ground, replenishing aquifers, and slowly moving through the ground to supply wells, springs, and surface water bodies

a) What is an aquifer? [01]

b) Describe the difference between confined and unconfined aquifers using a diagram. [03]

c) Describe the formation of cone of depression during groundwater pumping and explain how excessive pumping can create drying of nearby wells. Use diagrams when necessary. [04]

vii) Direct runoff due to a 12-hour storm event (shown in figure 1) is 4.7 inches. Calculate the average infiltration rate for the same 12-hour period. [03]

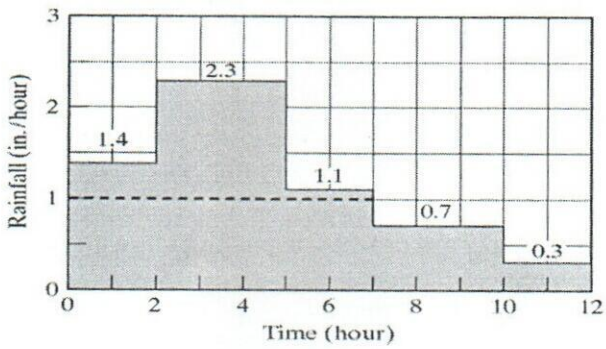

Figure 1

viii) The cyclone Ditwah triggered Sri Lanka's worst flood disaster in two decades, inundating nearly one-fifth of the island and killing over 600 people.

a) List three (3) types of floods that can occur in Sri Lanka [03]

b) State three (3) natural causes and two (2) human related causes for flooding. [05]

c) Elaborate three (3) structural solutions and three (3) non-structural solutions you proposed for flood control in Sri Lankan cities. [06]

d) What is the correlation between Return Period (T) and Exceedance Probability (P)? [03]

e) Describe a 25- year flood using exceedance probability. [02]

ix) Elaborate the multidisciplinary nature of hydrology and how you can use the knowledge acquired during this module in future career. [05]

Total [70]

SECTION B

Answer only two (2) questions out of given three (3) questions.

Q2. Precipitation denotes the all forms of water that reach the earth from the atmosphere. The distribution of precipitation and regional water demand creates water scarcity.

i) Name four (4) forms of precipitation that can be observed by a tropical country. [02]

ii) List three (3) key elements that require to result in a precipitation event. [03]

iii) Write two (2) recording type of rain gauges which used for point measurements and briefly describe operation of one unit. Use diagrams when necessary. [03]

iv) A catchment has five rain gauges. The annual rainfall recorded by each rain gauge station is summarized in Table 1 below. For a 5% error in the estimation of the mean rainfall, calculate the optimum number of rain gauge stations require for the catchment. [04]

v) When rain gauges are used for a long time, the inconsistencies in data can occur. Write at least three (3) causes for data inconsistencies in rain gauges. [03]

Total [15]

Q3. Evaporation in an open water bodies contributes a significant water loss in arid and semi-arid regions of the world.

i) Differentiate evaporation and boiling. [02]

ii) Write four (4) factors effecting evaporation in a waterbody. [02]

iii) Write three (3) types of evaporimeters used in evaporation measurements. [03]

iv) A reservoir has a water surface elevation of 155.450 m MSL at the beginning of January. Throughout that month, the reservoir experienced an average river inflow of 8.5 m^3/s and an average controlled release of 7.8 m^3/s. The reservoir surface directly received 110 mm of rainfall. If the water surface elevation at the end of January was 155.508 m MSL, and assuming the average surface area of the reservoir during the month of January was 4000 hectares with no significant groundwater interaction or other minor gains/losses, calculate the depth of evaporation loss from the reservoir surface during January. [04]

v) Briefly explain four [4] methods used to reduce evaporative water losses in engineering hydrological applications. [04]

Total [15]

Q4. Hydrographs are crucial in hydrology for understanding catchment behavior, designing flood mitigation systems, and managing water resources.

i) Draw a typical discharge hydrograph and demarcate base flow, peak flood and direct runoff [03]

ii) Differentiate Ephemeral Stream, Intermittent Stream and Perennial Stream based on stream flow. Use diagrams when necessary. [03]

iii) Describe the difference between hyetographs and hydrographs. In addition, explain the relationship of above graphs on defining time lag of direct runoff. Use diagrams when necessary. [04]

iv) Elaborate how the basin size, basin shape and basin slope effects the shape of the hydrograph. [03]

v) Defined a unit hydrograph and explain the application of unit hydrographs in hydrological prediction. [02]

Total [15]

Table 1 – Rain gauge recordings (For Question 2)

Station Name	A	B	C	D	E
Annual Rainfall (cm)	102.5	98.3	124.7	110.3	135.8

Supplementary Data;

Adequacy of Rain Gauge Stations;

$$n = \left(\frac{C_v}{\epsilon} \right)^2$$

$$\sigma = \sqrt{\frac{\sum (P_i - \bar{P})^2}{m}}$$

$$C_v = \left(\frac{\sigma}{\bar{P}} \right) \times 100$$

Where:

- n = Optimal number of rain gauges required
- ϵ = Allowable percentage of error in the estimation of the mean rainfall (usually determined by the user or hydrological standards)
- C_v = Coefficient of variation of the existing rain gauges (in percent)

End of the Question Paper

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Faculty of Engineering & Technology
Department of Civil Engineering
BSc. Hons. (Eng.) in Civil Engineering
Semester 4 First Sit - Final Examination 2026
Batch : 07

Module Code: CE2323	**Module Title: Structural Design I**
Date: 28.05.2026	**Duration: 3**
Examiner 1: Dr. Sumudu Herath	

Instructions to Candidates:

- *This is an open-book examination.*
- *This paper consists of four questions and 7 pages. Answer all questions.*
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Question 1

(a) According to EC2, the *Design Compressive Strength* of concrete (f_{cd}) is considered as $0.567f_{ck}$. By referring to appropriate equations, explain how this factor of *0.567* is obtained. [2 marks]

(b) A structural engineer has recommended the use of *C25/30 concrete* for the beams in a four-storey structure. Explain what is meant by this notation. [3 marks]

(c) A five-storey reinforced concrete building is to be used as an office building and the plan view at the third-floor level is shown in Figure Q1. Calculate the design load for **beam D(2-3)** for each of the three Serviceability Limit States of *Combination*, *Frequent* and *Quasi-permanent*, as specified in EC2. The following design information is provided. [10 marks]

- Unit weight of concrete = 25 kN/m^3
- Beam size: 400 mm x 250 mm
- Slab thickness: 150 mm
- Characteristic permanent load (excluding self-weight) acting on the slab: 1.5 kN/m^2
- Characteristic live load on the slab due to leading variable action = 2.5 kN/m^2
- Characteristic live load on the slab due to accompanying variable action = 1 kN/m^2

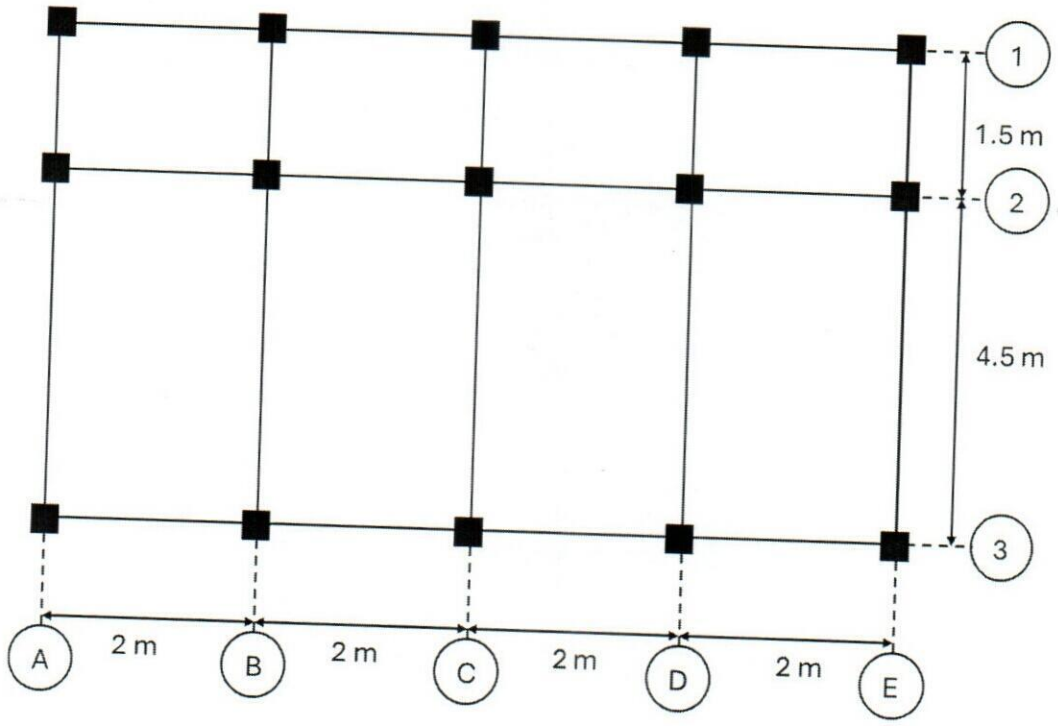

Figure Q1

[A Total of 15 marks for Question 1]

Question 2

a) Figure Q2 shows a simply supported reinforced concrete beam with a clear span of 6.2 m. The beam section is rectangular with a depth h and width b. The beam carries a permanent load g_k of 15 kN/m and a variable load q_k of 12 kN/m, in addition to its self-weight. The characteristic specific weight of the concrete can be assumed equal to 25 kN/m^3. The concrete class is C35/45 and the reinforcement is S500. The maximum aggregate size d_g is 14 mm, and the concrete cover c is 40 mm. In the following, you are asked to design the reinforced concrete beam in accordance with EN 1992-1-1.

i. State **two key considerations each** when you are doing the preliminary sizing of the beam depth and width. Based on that, select a suitable h and d.

[4 marks]

ii. Clearly explain the difference between **singly reinforced** beams and **doubly reinforced** beams.
Giving reasons, state whether you as a design engineer, prefer singly reinforced beams or doubly reinforced beams in your designs.

[4 marks]

iii. Compute the design bending moment M_{Ed} at Ultimate Limit State (ULS).

[3 marks]

iv. Find the main flexural reinforcement requirement $A_{s,req}$. Ensure that the spacing between the longitudinal reinforcement is sufficient to avoid bar congestion. Check whether the reinforcement provision satisfies the minimum and maximum reinforcement ratios stipulated in EN 1992-1-1.

[10 marks]

v. Providing a neat sketch, explain the **two key failure modes** of reinforced concrete beams in **shear**. Giving reasons, highlight the locations where design checks are performed to avoid these failures. [4 marks]

vi. Performing necessary design checks, calculate the required shear reinforcement area and the spacing A_{sw}/s. [10 marks]

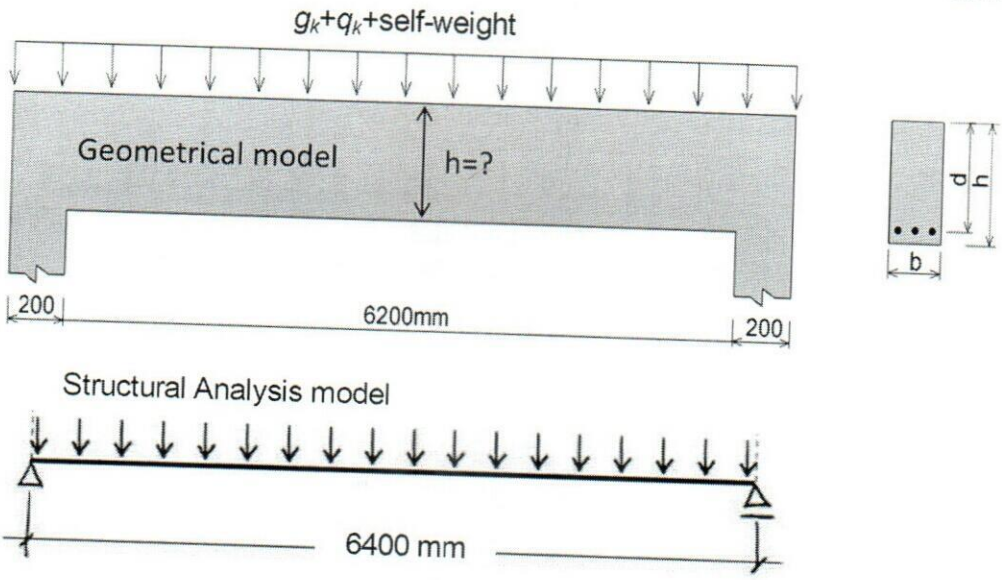

Figure Q2

[A Total of 35 marks for Question 2]

Question 3

a) Providing a neat sketch, clearly explain the **reason for the provision of secondary bottom reinforcement** parallel to the long span, although there is no bending moment in the long direction from the structural analysis of one-way spanning slabs. [4 marks]

b) Figure Q3 shows a four-span continuous solid slab spanning in one direction. Each span supports a permanent load g_k of 0.75 kN/m and a variable load q_k of 5 kN/m, in addition to its self-weight. The characteristic specific weight of the concrete can be assumed equal to 25 kN/m^3. The concrete class is C20/25 and the reinforcement is S500. Assume that the end support condition at the outer support is pinned. The absolute values of the ultimate bending moment near the middle of the end span and at the first interior support can be taken as $0.086FL$ where F is the total ultimate load and L is the effective span length. In the following, you are asked to design the reinforced concrete slab in accordance with EN 1992-1-1.

i. Briefly explain **two key considerations** when selecting an appropriate concrete cover. [4 marks]

ii. Giving reasons, select an appropriate preliminary estimate of the slab thickness. [2 marks]

iii. Performing the necessary design checks, compute the **main and secondary flexural reinforcement** requirements at the **middle of the end span**. [8 marks]

iv. Performing the necessary design checks, compute the **main and secondary flexural reinforcement** requirements at the **first interior support**. [8 marks]

v. Shear reinforcement is typically not provided in slabs. Briefly explain how concrete can resist shear without the provision of shear links. Compute the design shear resistance $V_{Rd,c}$ of the end span. [5 marks]

vi. Performing necessary design checks, verify whether the deflection of the end span is excessive.

[4 marks]

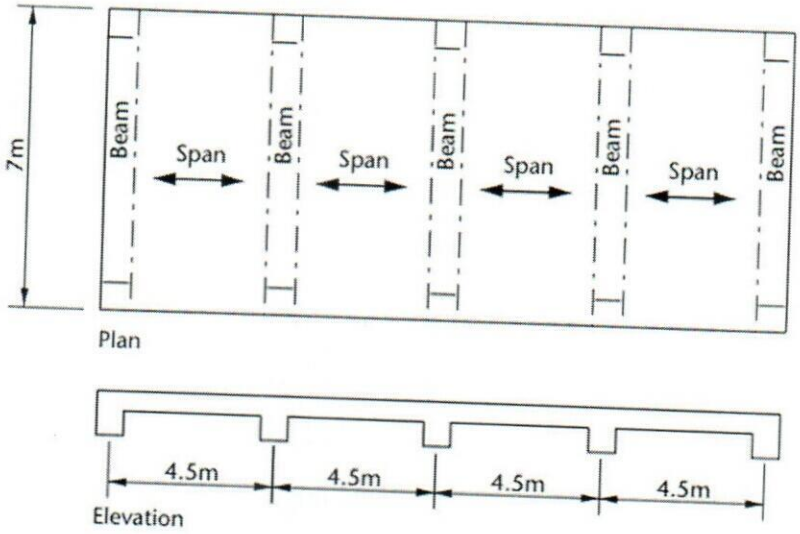

Figure Q3

[A Total of 35 marks for Question 3]

Question 4

a) Figure Q4 shows a plan view of a typical floor on a 4-storey school building (GF, 1F, 2F, 3F and Roof). You are supposed to design the column "P" at ground level, assuming that the column is subjected to an axial load only. The floor-to-floor height is 3.8 m. The density of concrete is 25 kN/m^3. C40/50 concrete will be used.

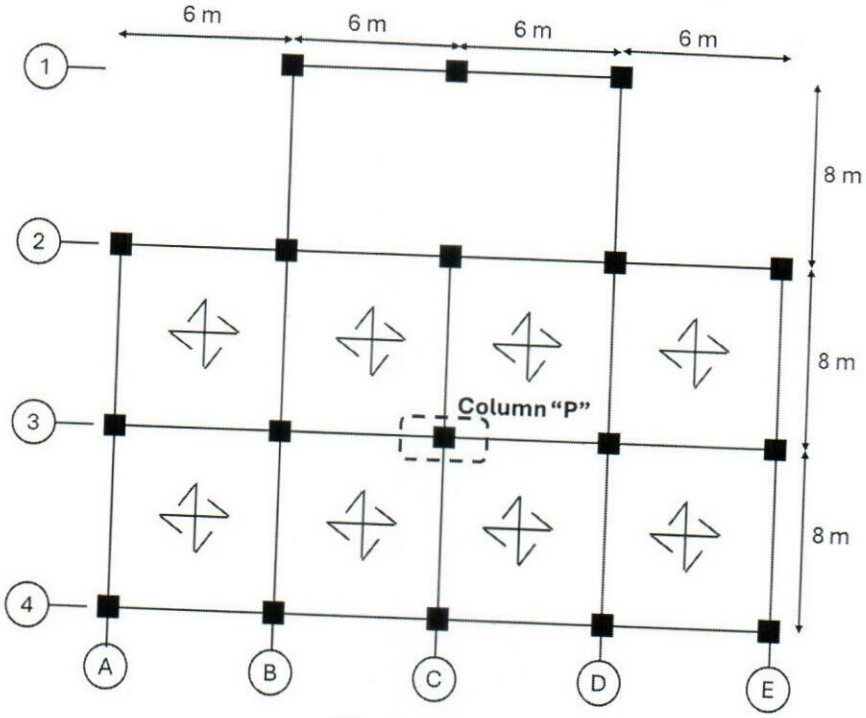

Figure Q4

i. Determine the ultimate limit state load that would be transferred to the internal column "P" from **a typical floor**. The column size is 350 mm x 350 mm. All beams are 500 mm x 350 mm. Consider a slab thickness of 150 mm. Live load on the floor slabs can be considered as 3 kN/m^2. [4 marks]

ii. Determine the total axial load that will act at the ground floor level on column P. Ultimate load from the roof can be estimated as 2 kN/m^2. [2 marks]

iii. Check whether the column part on the ground floor level is short or slender. The pad foundation is 1m below the ground level, and it is designed to resist moment. For this, you may take the slenderness limit (λ_{lim}) as 35. [5 marks]

iv. If the column is an axially loaded short column, then determine the reinforcement requirement using the charts given in IStructE manual. [4 marks]

[A Total of 15 marks for Question 4]

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