



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 4 -Final Examination 2025

Module Code	:	CE2326
Module Title	:	Surveying I
Date	:	July 2025
Examiners	:	Ms. Luckshi Ranasinghe
Time Allowed	:	3 hrs

Instructions to Candidates:

- This question paper consists of **seven** questions in **five** pages.
- Answer **any five** questions.
- The allocated time for the paper is **3 hours**.
- Show all stages of your work, with diagrams where appropriate.
- Drawings and sketches should be clear, neat and in approximate proportion.
- Do not use red ink.
- Maximum marks allocated for each section of questions are shown.
- Non-programmable calculators may be used.
- Start your answers to each question on a new page.
- Assume reasonable values for the data not given but state the assumed values.
- If you have answered more than five questions, either in part or in full, strike out the extra answers. Otherwise, only the first five answers appearing in the book will be evaluated.
- Any indications of copied work will be scrutinized heavily and may even subject to academic misconduct.

1)

- a) Compare topographic surveys and hydrographic surveys by explaining the techniques involved, their typical uses, as well as their advantages and limitations

(2 marks)

- b) Differentiate between systematic errors and random errors in surveying measurements, providing examples of each.

(2 marks)

- c) A steel tape of nominal length 30 m was used to transfer a level from a reference line near the base of a vertical concrete column to a reference line near its top. A 100 N weight was attached to its free end and the tape was hung freely down the side of the column such that its 100 mm mark was against the bottom reference line. A reading of 14.762 m was obtained at the top reference line. The tape used was standardized on the flat as 30.007 m at a tension of 50 N and a temperature of 20°C. It had a cross-sectional area of 1.9 mm², the coefficient of thermal expansion of the tape material was 0.0000112 per °C and Young's modulus was 210 kN/mm². During the measurement the mean temperature of the tape was 30°C. Calculate the vertical distance between the two reference lines.

$$\text{Young's modulus of steel} = 0.207 \times 10^6 \text{ N/mm}^2$$

$$\text{Coefficient of linear expansion of steel} = 1.15 \times 10^{-5} \text{ m per}^\circ\text{C}$$

$$\text{Weight per unit length} = 0.020 \text{ kg/m}$$

[The effect of standardization, temperature and pull on the length are $\frac{L(l-D)}{D}$, $(T_m - T_o)KL$, and $\frac{(P-P_o)L}{AE}$ respectively, in standard notation.]

(16 marks)

2)

- a) A plot of land given in Figure Q2, consisting of a rectangle and an adjoining triangle, is shown on a map drawn to a scale of 1 cm : 100 m. The rectangle measures 30 cm in width and 50 cm in length, and the sides of the triangle measure 30 cm and 20 cm on the map. A new map is to be drawn using a scale of 1 cm : 150 m. What will be the area of the same plot of land on the new map?

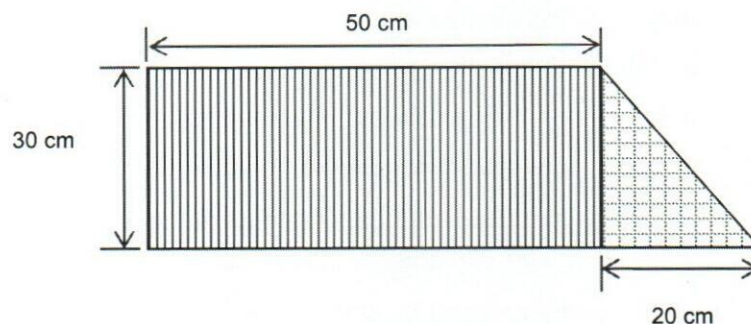


Figure Q2

(10 marks)

- b) The coordinates of stations S, A, and L are $E_S = 1309.12$ m E, $N_S = 1170.50$ m N, $E_A = 1525.43$ m E, $N_A = 958.87$ m N, $E_L = 1231.08$ m E and $N_L = 565.81$ m N. Calculate the coordinates of point B which has been located by intersection from stations S, A and L by observing the following angles: $\angle BSA = 85^\circ 38' 49''$, $\angle SAB = 55^\circ 50' 53''$, $\angle BAL = 41^\circ 41' 48''$ and $\angle ALB = 68^\circ 09' 32''$.

(10 marks)

3)

- a) What is the purpose of a fly back when conducting a levelling survey?

(4 marks)

- b) The level sheet given in Table Q3 is missing several readings. Fill in the gaps using the rise and fall method by calculating and verifying the error using the relevant checks.

Table Q3

BS	IS	FS	Rise	Fall	RL	Adjustment	Adjusted RL	Remark
A					49.873	-	49.873	BM 1
	2.505			0.314	49.559	+0.002	49.561	A
	2.325		B		X1	X5	X9	B
C		1.496	0.829		X2	X6	X10	C (CP)
	2.513		D		X3	X7	X11	D
E		F		0.298	X4	X8	X12	E (CP)
		3.824		2.072	48.704	+0.006	48.710	TBM 2
Σ BS 6.962		Σ FS G	Σ Rise H	Σ Fall 2.684				

(16 marks)

4)

- a) Explain how you would apply the transit rule to adjust a traverse when the coordinates of the starting and ending stations are known

(5 marks)

- b) The following fore and back bearings were observed in traversing with a compass. Calculate interior angles and correct them for observational errors.

Table Q4

Line	Whole Circle Bearing	Length (m)
PQ	S37°30'E	N37°30'W
QR	S43°15'W	N44°15'E
RS	N73°00'W	S72°15'E
ST	N12°45'E	S13°15'W
TP	N60°00'E	S59°00'W

(15 marks)

5)

- a) What is the collimation error in surveying instruments, and how can it affect traverse results? Describe how this error can be detected and minimized.

(5 marks)

- b) An abstract from a traverse sheet for a closed traverse is given in Table Q5.

Table Q5

Line	Length (m)	Latitude	Departure
PA	200	-173.20	+100.00
AB	130	0.00	+130.00
BC	100	+86.00	+50.00
CD	250	+250.00	0.00
DQ	320	-154.90	-280.00

- (i) Balance the traverse by Bowditch's method.

(5 marks)

- (ii) Given that the coordinates of A are 200 N, 00 E, determine the coordinates of other points.

(5 marks)

- (iii) Calculate the enclosed area in hectares by the coordinate method.

(5 marks)

6)

- a) Describe the principles of tacheometry and explain situations where it is more advantageous than direct levelling and chaining in surveying.

(5 marks)

- b) With the aid of a diagram, explain the stadia method used in tacheometry. Highlight the role of the stadia interval and how distance is calculated.

(5 marks)

- c) A survey used tacheometry to identify the distance between two points X and Y. The instrument was leveled at a height of 1.38m at point A, which has an elevation of 45.60m. The readings obtained are given in Table Q6 shows a plan view of the site. [The multiplying constant of the instrument is 100 and the additive constant 0]

Table Q6

Staff Position	Horizontal Reading	Vertical Reading	Stadia Reading (m)
D	56°49'31"	87°38'53"	3.240, 3.047, 2.853
L	98°07'18"	92°21'36"	2.458, 2.230, 2.002

- (i) Find the reduced level of points D and L

(5 marks)

- (ii) Find the horizontal length of DL

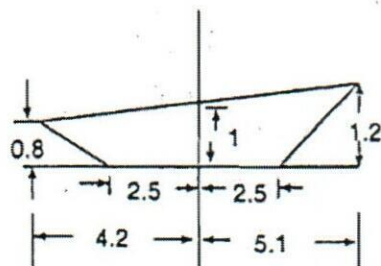
(5 marks)

7)

- a) The following offsets, 8 m apart were measured at right angles from a traverse line to an irregular boundary. 0 m, 2.3 m, 5.5 m, 7.9 m, 8.6 m, 6.9 m, 7.3 m, 6.2 m, 3.1 m and 0 m. Using Simpsons rule, calculate the area between the traverse line and the irregular boundary.

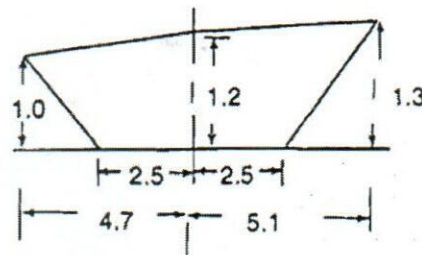
(10 marks)

- b) An irrigation ditch is with a based width of 5 m and side slopes 2 to 1. The distance from centre line and cut ordinates for stations 52 + 00 and 53 + 00 are c 0.8/4.2, c 1.0, c 1.2/5.1 and c 1/4.7, c 1.2, c 1.3/5.1. Compute the volumes by average end area method (Fig: 14.32). given in Figure Q7-1.



(a)

(a) Section at 52 + 00.



(b)

(b) Section at 53 + 00.

Figure Q7 - 1

(10 marks)

CE2324

Final Examination

Hydrology



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Eng (Hons) Civil Engineering
Semester 4 -Final Examination 2025

Module Code : CE2324
Module Title : Hydrology
Date : 13th July 2025
Examiners : Umal Fernando
Time Allowed : 3 hrs

Instructions to Candidates:

- This is a **closed book** examination
- This paper consists of five (05) questions. Answer **all five** questions.
- Use only the answers booklet, additional papers and graph paper for your answers.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Marks will be deducted for missing or incorrect measuring units.
- If You have any doubt regarding the interpretation of the wording of a question, **make your own assumptions and clearly state** it on the answer script.

- Q1) a) Hydrology is the study of science that deals with the occurrence, circulation and distribution of water of the earth and earth's atmosphere. Briefly explain the application of engineering hydrology in Civil engineering. (2 marks)
- b) Precipitation is one of the major components in the hydrological cycle.
- i) State the 3 major types of precipitation describing the mechanism of each type. (3 marks)
- ii) The isohyets due to a storm in a watershed having 558 km² area is shown in Table 1.1 with the area of the catchment bounded by the isohyets. Estimate the mean precipitation due to the storm. (3 marks)
- c) Estimation of evaporation loss is important in water resource management.
- i) Evaporimeters are one of the methods available to measure evaporation. Name 3 such evaporimeters highlighting their associated limitations. (2 marks)
- ii) A reservoir has a water surface elevation of 155.450 m MSL at the beginning of October. Throughout that month, the reservoir experienced an average river inflow of 8.5 m³/s and an average controlled release of 7.8 m³/s. The reservoir surface directly received 110 mm of rainfall. If the water surface elevation at the end of October was 155.508 m MSL, and assuming the average surface area of the reservoir during October was 4000 hectares with no significant groundwater interaction or other minor gains/losses, calculate the depth of evaporation loss from the reservoir surface during October. (4 marks)
- Q2) a) Hydrograph is a representation of the discharge vs. time or stage vs. time, at a specific location. Briefly explain the following terms with regards to the hydrographs' time characteristics:
- Time of concentration
 - Lag time. (2 marks)
- b) i) Name the 3 methods of base flow separation from a stream flow hydrograph. (1.5 marks)
- ii) The streamflow hydrograph of a stream at the basin outlet is given in Table 2.1. Estimate the base flow using an appropriate method you mentioned above. (4.5 marks)

- c) A rural area, currently consisting of a small agricultural catchment with cultivated land under contouring (without conservation), is classified under Hydrologic Soil Group C. A significant storm event occurred, delivering a total rainfall of 120 mm over a short duration. Assume average antecedent moisture conditions (AMC I).
- i) Calculate the direct surface runoff depth (in mm) generated by this storm for the current agricultural condition of the catchment. (2 marks)
- ii) A new urban development project is now planned for this exact catchment area. Following urbanization, the land use is projected to change significantly, with the following distribution for Hydrologic Soil Group C:
- High-Density Residential Areas (e.g., apartments, townhouses): 50%
 - Industrial Areas (extensive impervious surfaces): 30%
 - Streets and roads (Paved with curbs and storm sewers): 20%

For the same 120 mm storm event, determine the direct surface runoff depth (in mm) for this urbanized condition. (4 marks)

- Q3) a) i) What is a Unit Hydrograph? (2 marks)
- ii) The ordinates of the 2-h unit hydrograph of a watershed are given in Table 3.1. Determine the ordinates of the S2-curve hydrograph and using this S2 curve determine the ordinates of the 4-h unit hydrograph of the basin. (5 marks)
- b) What is known as synthetic unit hydrograph? Explain with the associated merits. (2 marks)
- c) The annual maximum peak discharges recorded at the Kalu Ganga at Ratnapura station for a five-year period (2015-2019) are provided in Table 3.2. A new flood mitigation and early warning system is being designed for this area, intended to be effective for the next 3-year period. Engineers consider an event "critical" if it has at least a 60% probability of occurring once or more within this 3-year design period. Calculate the total annual maximum discharge (in m^3/s) that should be considered when developing this 3-year mitigation plan, based on the given criterion. (5 marks)

- Q4) a) i) Distinguish between confined and unconfined aquifers. (2 mark)
- ii) A confined stratified aquifer has a total thickness of 12 m and is made up of 3 layers. The layers have coefficient permeability of 35 m/day, 20 m/day and 28 m/day from the bottom. The topmost layer is having 3.5 m thickness while bottom two layers are having the same thickness. Calculate the transmissivity of the aquifer and the equivalent permeability, if the flow is along the stratification. (3 marks)

- b) Show that the steady one-dimensional unconfined ground water flow with a recharge rate R is given by the following differential equation with usual notation. State the assumptions made.

$$\frac{\partial^2 h^2}{\partial x^2} = \frac{-2R}{k} \quad (4 \text{ marks})$$

- c) A 45 cm well in an unconfined aquifer was pumped out at a constant rate of 1500 lpm. At the equilibrium stage the following drawdown values at 2 observation wells were noted. Well A with 10 m radial distance has 5m draw down and well B with 30 m radial distance has 2 m drawdown. The saturated thickness of the aquifer is 45 m. Assuming the radius of influence to be proportional to the discharge in the pumping well, calculate the drawdown at the pumping well.

(Hint: Use radius of influence $R = cQ$ where c is a constant)

$$Q = \pi k \frac{(h_1^2 - h_2^2)}{\ln \frac{r_1}{r_2}} \quad (5 \text{ marks})$$

- Q5) a) The normal annual rainfall at 4 stations named P,Q,R and S in a watershed are 80.88, 75.59, 76.23 and 85.26 respectively. In the year 2022, the station R was inoperative and the stations P, Q, S recorded annual precipitations of 80.53, 86.22 and 76.56 cm respectively. Estimate the rainfall at station R in the year 2022. (3 marks)
- b) Describe the Double mass curve technique to check the inconsistency of rainfall record. (2 marks)
- c) i) Name direct and indirect methods of stream flow determination. (2 marks)

CE2324

Final Examination

Hydrology

- ii) During a stream gauging operation on a small river, a cross-section was selected and divided into several vertical segments. The distance from the left bank, water depth, and average velocity in each vertical were measured. The data collected is presented in Table 5.1. calculate the total discharge of the river in m^3/s . (5 marks)
- d) What is meant by IDF curve? (2 marks)

Table 1.1: Isohyetal Data

Isohyetal interval (cm)	15-12	12-9	9-6	6-3	3-1
Inter-isohyetal area (km ²)	82	116	125	162	73

Table 2.1

Time (days)	0	2	4	6	8	10	12	14	16	18	20	22
Q (m ³ /s)	3	2.5	6	14	17	13	10	7	5	3	2.5	2.5

Table 3.1

Time (h)	0	2	4	6	8	10	12	14	16	18	20	22
Ordinate (m ³ /s)	0	25	100	160	190	170	110	70	30	20	6	0

Table 3.2

Year	2015	2016	2017	2018	2019
Annual Maximum discharge (m ³ /s)	1850	2100	1700	2400	1950

Table 5.1

Measurement point (From left bank, m)	0	1.5	3	4.5	6	7.5
Depth (m)	0	0.8	1.2	1.5	1.0	0
Avg. vertical velocity (m/s)	0	0.35	0.55	0.62	0.4	0

Time interval from peak to end point of direct runoff (DRO) is given by.

$$N \text{ (days)} = bA^{0.2}$$

$$P_e = \frac{(O - 0.2S)^2}{P + 0.8S}; \text{ where } CN_I = \frac{4.2CN_{II}}{10 - 0.058CN_{II}} \text{ and } S = \frac{1000}{CN} - 10$$

Weibull Formula:

$$P = \frac{m}{N + 1}$$

Equivalent permeability: (Flow is normal to stratification)

$$K_e = \frac{\sum_i^n L_i}{\sum_i^n \frac{L_i}{K_i}}$$

Equivalent permeability: (Flow is parallel to stratification)

$$K_e = \frac{\sum_i^n K_i B_i}{\sum_i^n B_i}$$

Width of first and last segments:

$$\bar{W}_1 = \frac{(W_1 + \frac{W_2}{2})^2}{2W_1} \text{ and } \bar{W}_{N-1} = \frac{(W_N + \frac{W_{N-1}}{2})^2}{2W_N}$$

Land Use Description	Hydrologic Soil Group			
	A	B	C	D
Cultivated land ¹ :				
without conservation treatment	72	81	88	91
with conservation treatment	62	71	78	81
Pasture or range land:				
poor condition	68	79	86	89
good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or forest land:				
thin stand, poor cover, no mulch	45	66	77	83
good cover ²	25	55	70	77
Open spaces, lawns, parks, golf courses, cemeteries, etc.				
Good condition: grass cover on 75% or more of the area	39	61	74	80
Fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious)	81	88	91	93
Residential ³ :				
Average lot size Average % impervious ⁴				
1/8 acre or less 65	77	85	90	92
1/4 acre 38	61	75	83	87
1/3 acre 30	57	72	81	86
1/2 acre 25	54	70	80	85
1 acre 20	51	68	79	84
Paved parking lots, roofs, driveways, etc. ⁵	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers ⁵	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89
1. For a more detailed description of land use curve numbers, refer to Soil Conservation Service 1972, Chap. 9.				
2. Good cover is protected from grazing and litter and brush cover soil.				
3. Curve numbers are calculated assuming the runoff from the house and driveways is directed towards street with a minimum of roof water directed to lawns where additional infiltration could occur.				
4. The remaining previous areas (lawn) are considered to be in good pasture condition for these curve numbers.				
5. In some warmer climates of the country a curve number of 95 may be assumed.				



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 4 First Sit - Final Examination 2025

Module Code : CE2323
Module Title : Structural Design I
Date : 09th July 2025
Examiners : Mr. Dhanuka Madhushan
Time Allowed : 3 hrs

Instructions to Candidates:

- This is an **open book** examination.
- This paper consists of Four (04) questions. Answer **all four** questions.
- Use only the answers booklet, and additional papers for your answers.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question should not be scattered.
- Marks will be deducted for missing or incorrect measuring units.
- You are advised to make a clear diagram for each question, where appropriate. This will help you to perform calculations correctly.
- If You have any doubt regarding the interpretation of the wording of a question, make your own assumptions and clearly state it on the answer script.

Question 1)

You are assigned as a structural engineer for the design of a three-storey residential building. The architectural second floor plan of the house is shown in **Figure 1**, with all dimensions given in millimeters. The structural framing includes reinforced concrete beams with a uniform cross-section of **250 mm (width) × 400 mm (depth)**. Use a **concrete cover of 25 mm** and adopt $f_{ck} = 25 \text{ MPa}$ and $f_{yk} = 500 \text{ MPa}$ for material strengths.

You are required to design and detail **Beam B**. **Figure 2** provides the bending moment diagram for Beam B, and **Figure 3** provides the shear force diagram. Assume the slab thickness to be **150 mm**.

You need to perform the following tasks. All calculations and design checks must comply with **Eurocode 2 (EC2)** and include appropriate clause references:

- a) **Design the main reinforcement** at the **support at Point 2** of Beam B. Provide a clear reinforcement sketch showing bar arrangement and detailing.
(7 Marks)
- b) **Design the main reinforcement** at the **midspan between Points 2 and 3** of Beam B. Provide a reinforcement sketch. Consider the contribution of the slab (150 mm thick) to the overall section properties.
(10 Marks)
- c) **Verify** that the designed reinforcement meets the **minimum and maximum reinforcement limits** as specified in EC2. Take $f_{ctm} = 2.6 \text{ MPa}$.
(3 Marks)
- d) **Design the shear reinforcement** for Beam B between Points 2 and 3. Assume the **maximum shear force at Point 2** as the design shear force. Calculate the appropriate stirrups spacing.
(10 Marks)
- e) **Check the deflection** of Beam B (between Points 2 and 3) against serviceability limits as per simplified method of EC2 requirements.
(10 Marks)

Question 2)

Based on the same project scenario described in Question 1, you are required to design the **corner slab panel AB34 (Figure 1)** of a reinforced concrete floor system. The slab has a thickness of **150 mm**, a concrete cover of **25 mm**, and is made with materials of characteristic strengths $f_{ck} = 25 \text{ MPa}$ and $f_{yk} = 500 \text{ MPa}$. All calculations must be carried out in accordance with **Eurocode 2 (EC2)**.

- a) Determine whether the slab panel AB34 behaves as a **one-way** or **two-way** slab. Then, Calculate the **total design load** acting on the slab, applying appropriate **partial safety factors** as per EC2. Assume, Concrete self weight = 25 kN/m^3 , Floor Finishes load = 1 kN/m^2 , Imposed Load = 4 kN/m^2 .
(3 Marks)
- b) Using **Table 1** (moment coefficient table), determine the **bending moment coefficients** for both the **short** and **long** directions of the slab. Draw the **bending moment diagrams** in both directions, clearly indicating span and support moments.
(9 marks)
- c) Calculate the **required reinforcement spacing** at **mid-span** and **near supports** in both directions of the slab. Verify that the proposed spacing complies with **maximum allowable bar spacing requirements** in EC2.
(16 Marks)
- d) Prepare a **detailed structural drawing** of the slab panel AB34. .
(2 Marks)

Question 3)

You are working as a structural engineer on a **two-storey office building project**. **Figure 4** shows the critical cross-sectional view of a column located on the **first floor** of the structure. This column is subjected to the following design actions:

- **Axial load: 500 kN**
- **Top-end bending moments:**
 - About the y-axis: 100 kNm
 - About the z-axis: 40 kNm
- **Bottom-end bending moments:**
 - About the y-axis: 60 kNm
 - About the z-axis: 20 kNm

The **column** has a square cross-section of **250 mm × 250 mm**, and it is connected to **beams** with a cross-section of **250 mm × 350 mm** and spans of **5.0 m**. Use $f_{ck} = 30 \text{ MPa}$ and $f_{yk} = 500 \text{ MPa}$ for material properties.

You are required to design and assess the column based on the guidelines provided in Eurocode 2 (EC2). All calculations must include the appropriate clause references.

- a) Assuming that the columns are **braced**, determine whether the column is **short** or **slender** in both the y and z directions, as per EC2.
(7 Marks)

- b) Assuming an effective depth ratio (d_z/h) = 0.2, determine the required longitudinal reinforcement for the column in both directions. Use the interaction design chart provided in **Figure 5** to support your calculations. (9 Marks)
- c) Check whether the designed reinforcement complies with the **minimum and maximum reinforcement requirements** according to EC2. (2 Marks)
- d) Design the **shear link spacing** for the column to ensure adequate confinement and shear resistance. (2 Marks)

Question 4)

Referring to the same project scenario described in **Question 3**, you are required to design a **reinforced concrete square pad footing** to support the **critical ground floor column**. The column has dimensions of **250 mm × 250 mm** and carries a **service load of 620 kN** and an **ultimate load of 800 kN**. The **allowable bearing pressure** of the soil is **200 kN/m**. Consider concrete cover of **50 mm** and is made with materials of characteristic strengths $f_{ck} = 25 \text{ MPa}$ and $f_{yk} = 500 \text{ MPa}$.

- a) Determine the **required plan dimensions** (length and width) of the **square pad footing** based on the service column load and allowable soil bearing pressure. Also, Calculate the **required depth** and **effective depth** of the footing. (3 Marks)
- b) Design the **main reinforcement** for the footing and determine the required **bar spacing**, ensuring compliance with EC2 provisions for bending and spacing requirements. (6 marks)
- c) Prepare a **detailed structural drawing** of the pad footing. (1 Marks)

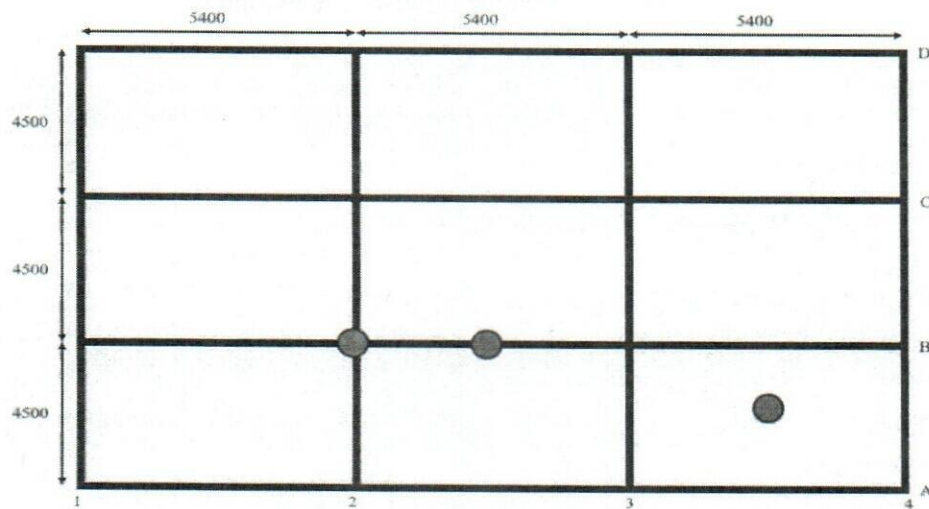


Figure 1 : Floor plan of the second floor

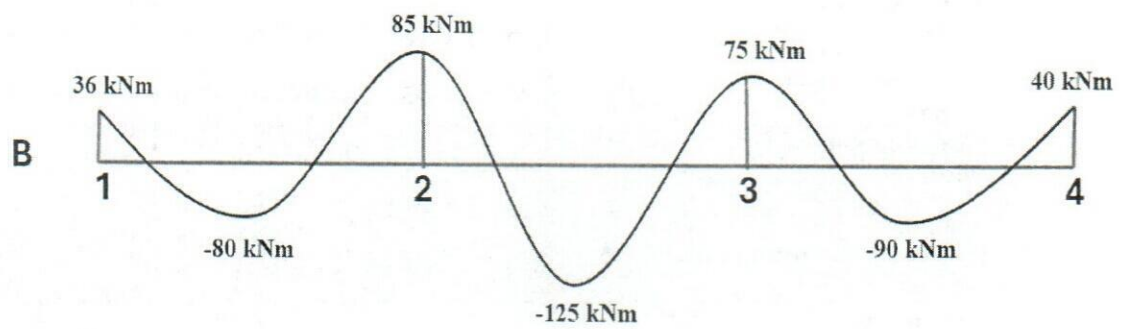


Figure 2 : Bending Moment Diagram of beam B

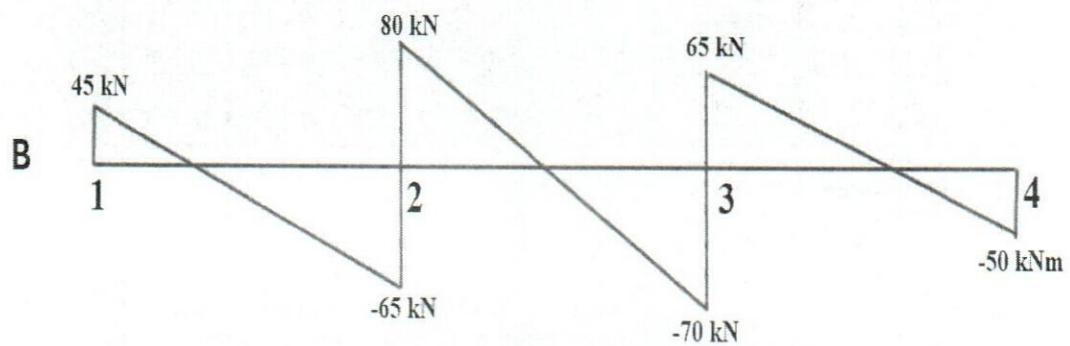


Figure 3 : Shear Force Diagram of beam B

Table 1 : Bending Moment Coefficients

Type of panel and moments considered	Short span coefficients β_{sx} Values of l_y/l_x					Long-span coefficients β_{sy} for all values of l_y/l_x
	1.00	1.20	1.50	1.75	2.00	
1 Interior panels:						
Negative moment at continuous edge	0.031	0.042	0.053	0.059	0.063	0.032
Positive moment at Mid span	0.024	0.032	0.040	0.044	0.048	0.024
2 One short edge discontinuous:						
Negative moment at continuous edge	0.039	0.048	0.058	0.063	0.067	0.037
Positive moment at Mid span	0.029	0.036	0.043	0.047	0.050	0.028
3 One long edge discontinuous:						
Negative moment at continuous edge	0.039	0.056	0.073	0.082	0.089	0.037
Positive moment at Mid span	0.030	0.042	0.055	0.062	0.067	0.028
4 Two adjacent edges discontinuous:						
Negative moment at continuous edge	0.047	0.063	0.078	0.087	0.093	0.045
Positive moment at Mid span	0.036	0.047	0.059	0.065	0.070	0.034
5 Two short edges discontinuous:						
Negative moment at continuous edge	0.046	0.054	0.062	0.067	0.070	-
Positive moment at Mid span	0.034	0.040	0.047	0.050	0.053	0.034
6 Two long edge discontinuous:						
Negative moment at continuous edge	-	-	-	-	-	0.045
Positive moment at Mid span	0.034	0.056	0.078	0.091	0.100	0.034
7 three edges discontinuous (one long edge continues):						
Negative moment at continuous edge	0.057	0.071	0.084	0.092	0.098	-
Positive moment at Mid span	0.043	0.053	0.063	0.069	0.074	0.044
8 three edges discontinuous (one short edge continuous):						
Negative moment at continuous edge	-	0.054	0.062	0.067	0.070	-
Positive moment at Mid span	0.042	0.040	0.047	0.050	0.053	0.034
9 Four edges discontinuous						
Positive moment at mid span	0.055	0.074	0.092	0.103	0.111	0.056

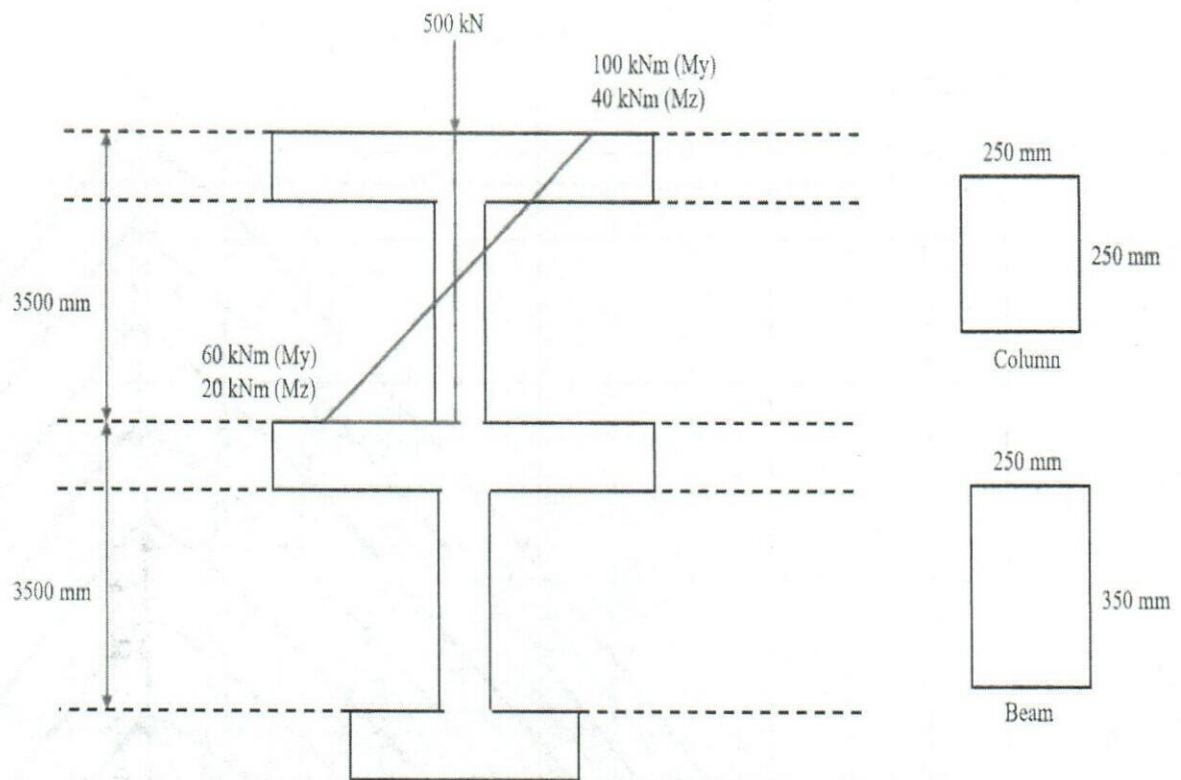
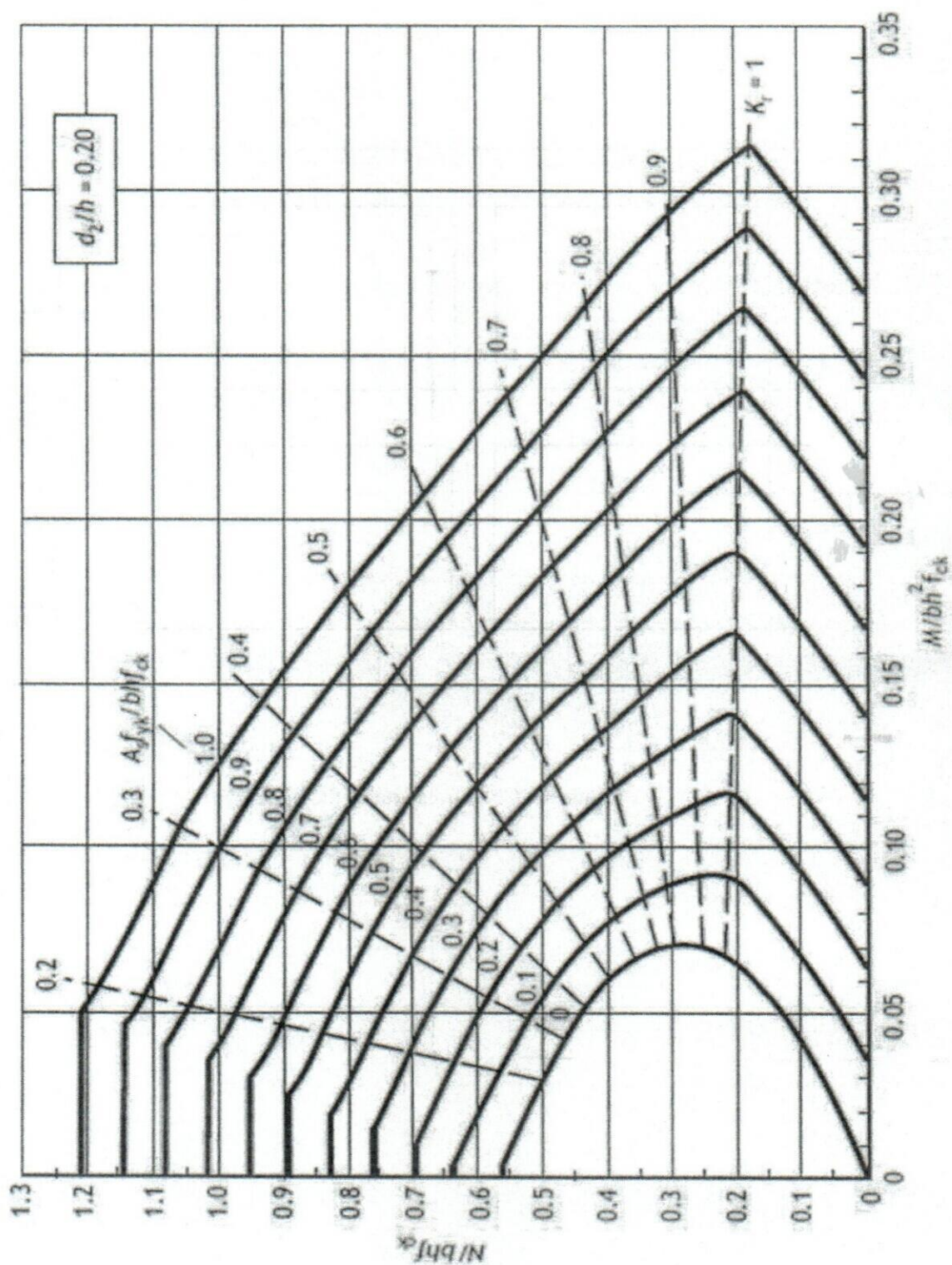


Figure 4 : Column layout of the building

Figure 5 : Column design chart $d_2/h = 0.2$



Final examination

Building Engineering



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 6 First Sit - Final Examination 2025

Module Code : CE3325
Module Title : Building Engineering
Date : 25th June 2025
Examiners : Mr. Dhanuka Madhushan
Time Allowed : 3 hrs

Instructions to Candidates:

- This is a **closed book** examination.
- This paper consists of Four (04) questions. Answer **all four** questions.
- Use only the answers booklet, and additional papers for your answers.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question should not be scattered.
- Marks will be deducted for missing or incorrect measuring units.
- You are advised to make a clear diagram for each question, where appropriate. This will help you to perform calculations correctly.
- If You have any doubt regarding the interpretation of the wording of a question, make your own assumptions and clearly state it on the answer script.

Question 1)

- a) **Briefly explain** the importance of both horizontal and vertical circulation in high-rise buildings, highlighting their role in functionality and user convenience.
(2 Marks)
- b) **Identify and list three** primary types of elevators and name **five** key components of a lift system.
(4 Marks)
- c) **Discuss** the essential safety features incorporated in modern elevator systems to ensure passenger safety.
(4 marks)
- d) Propose a suitable elevator system design for a **10-story, 3-star hotel** with a **ground-floor car park** and **20 rooms per floor**. The floor-to-floor height is **4m**. Prioritize **efficient customer service** over cost considerations and use the data sheets provided in **Appendix 1** for calculations.
(10 Marks)

Question 2)

- a) Discuss the role of fire sprinkler systems in fire safety within high-rise buildings, explaining their operational mechanisms and classification based on types.
(5 Marks)
- b) As a junior civil engineer at a local engineering consultancy working on the expansion of a **private educational institution** located in a semi-urban area without access to a centralized sewerage system, you are asked to design an appropriately sized septic tank. The institution accommodates an average of **200 students daily**, and all wastewater from toilets, handbasins, and limited canteen use must be treated on-site. Use a **wastewater flow rate of 100 litres per person per day** and assume a **desludging interval of 4 years** as preferred by the institution to reduce maintenance frequency.

Tasks : Determine the **required septic tank capacity** / Draw a **cross-sectional sketch** of the proposed septic tank. (Refer to the Appendix 2)

(15 marks)

Question 3)

- a) Describe the **importance of the water seal** in traps in sanitary appliances. Why is it essential for hygiene and system performance?
(1 Marks)

- b) List **four key design considerations** when selecting or installing sanitary appliances in a commercial office setting.
(2 Marks)
- c) Using a graph, explain the **pressure effects** caused by water flow in a **discharge stack** of a multi-storey building. Highlight how these pressures can impact trap seals.
(3 Marks)
- d) Briefly explain **five common reasons for water seal losses** in traps. Use simple sketches to illustrate each.
(5 Marks)
- e) Recommend a **suitable above-ground drainage system** for a two-storey office building. Justify your choice in terms of cost, maintenance, and performance.
(2 Marks)
- f) You are hired as a junior building services engineer for the design of a two-storey (G+1) office building intended to house 90 occupants per floor, with 20% female staff. The vertical distance between floors is 3.5 meters, and an overhead water tank is located 1.5 meters above the roof. Sanitary appliances are to be grouped on each floor, with 1 meter spacing between fixtures. Your design should comply with standard plumbing and drainage codes, ensuring hygienic and functional performance.
- i. Calculate the required number of water closets and wash basins per floor for both male and female users, based on standard guidelines. Show all working clearly. (Refer to the Appendix 3)
(4 Marks)
- ii. Develop a **plan view layout** showing the arrangement of the sanitary appliances on a typical floor. Maintain logical grouping and spacing.
(2 Marks)
- iii. Determine suitable **pipe diameter** for vertical stack. (Refer to the Appendix 3)
(4 Marks)
- iv. Draw the **complete cold water pipeline arrangement** for the building. (Use the incomplete drawing in Attachment 1 and attach it separately to the answer booklet.)
(2 Marks)
- v. Check whether the assumed pipe diameters in attachment 1 are sufficient for an efficient water distribution system. Assume **copper pipes and fittings**. Also assume a **1m height discharge point of water** for all appliance above the floor level. (Refer to the Appendix 3 and use the incomplete table in Attachment 2 and attach it separately to the answer booklet.)
(15 Marks)

Question 4)

- a) Provide an explanation of how **building orientation** and **ventilation strategies** influence thermal comfort inside buildings.

(3 Marks)

- b) You have been appointed as a junior HVAC engineer for a government-sponsored **start-up incubator project** in Galle, Sri Lanka. Your specific role is to design a **mechanical ventilation system** for a modern **co-working space** that caters to young professionals, remote workers, and freelancers. This space operates during peak daytime hours and experiences **high occupant density**, requiring reliable ventilation and thermal comfort to ensure occupant productivity and air quality. In line with post-pandemic indoor air quality standards, **100% fresh air intake is required** — recirculation is not permitted.

Ambient Outside Air Conditions : Dry Bulb Temperature (DBT): 34 °C / Relative Humidity (RH): 30%

Target Indoor Conditions: Dry Bulb Temperature (DBT): 20 °C / the same moisture content is assumed for both indoor and outdoor air.

Using the **psychrometric chart in appendix 4**, determine the following for both **outside air** and **cooled indoor air**.

- | | | |
|------|--|-----------------|
| I. | Determine the wet bulb temperature (°C). | (1 mark) |
| II. | Find the dew point temperature (°C). | (1 mark) |
| III. | Obtain the moisture content in kg of water per kg of dry air. | (1 mark) |
| IV. | Determine the relative humidity (RH) | (1 mark) |
| V. | Find the enthalpy of the heated air in kJ/kg of dry air. | (1 mark) |
| VI. | Identify the specific volume in m ³ /kg of dry air. | (1 mark) |
- c) You are part of the MEP (Mechanical, Electrical, and Plumbing) design team working on the expansion of a **government technical training college in Kurunegala**. Your task is to **design the air conditioning system** for a new **computer laboratory** located on the **second floor** of the academic block. The lab accommodates **20 students and instructors** during class hours and is continuously operated for up to **8 hours per day** due to multiple shifts and lab sessions. The room is bounded by **non-conditioned zones**, creating high external heat gain: The **ceiling is directly beneath a concrete roof slab**, with **no insulation**. The **floor lies over a semi-enclosed open corridor**, exposed to outdoor air from three sides. Ambient temperature is 90° F.

Use the following summary table (Table Q4) and figure Q4 for design parameters.

Table Q4 : Design parameters

Parameter	Value
Number of Occupants	20 readers
Electrical equipment Load	10 × 20 W fluorescent bulbs / 25 × 60 W laptops
Ceiling	Ceiling with no insulation
Floor	Above unconditioned space
Wall	Cement blocks

- I. Estimate the total cooling load in BTU/hr. Use the table in attachment 3.
(7 marks)
- II. Calculate the Number of Air Conditioners required, if an efficient service is required than the cost effectiveness. You're planning to use standard inverter-type split ACs rated at 18,000 BTU/hr .
(1 mark)
- III. Calculate the Total Cooling Capacity of the selected ACs in kW. (1W= 3.412 BTU/hr)
(1 mark)
- IV. Calculate the electrical input power requirement in kW if the coefficient of performance (CoP) is 3.5.
(1 mark)
- V. Calculate Daily Energy Consumption in kWh, if the ACs operate on average for 8 hours per day.
(1 mark)

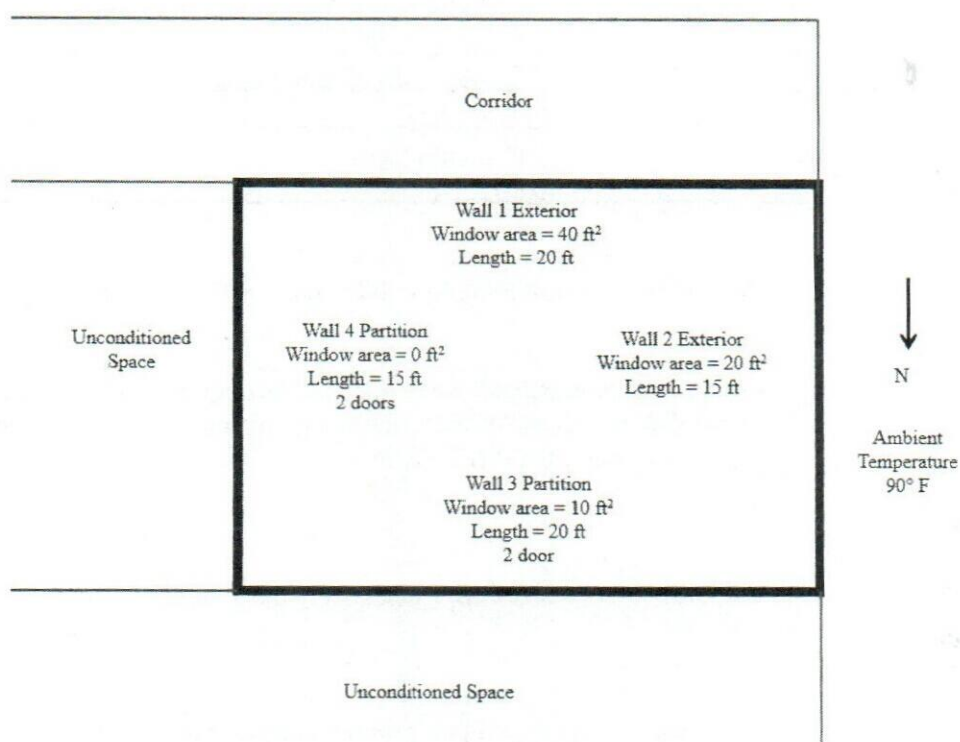
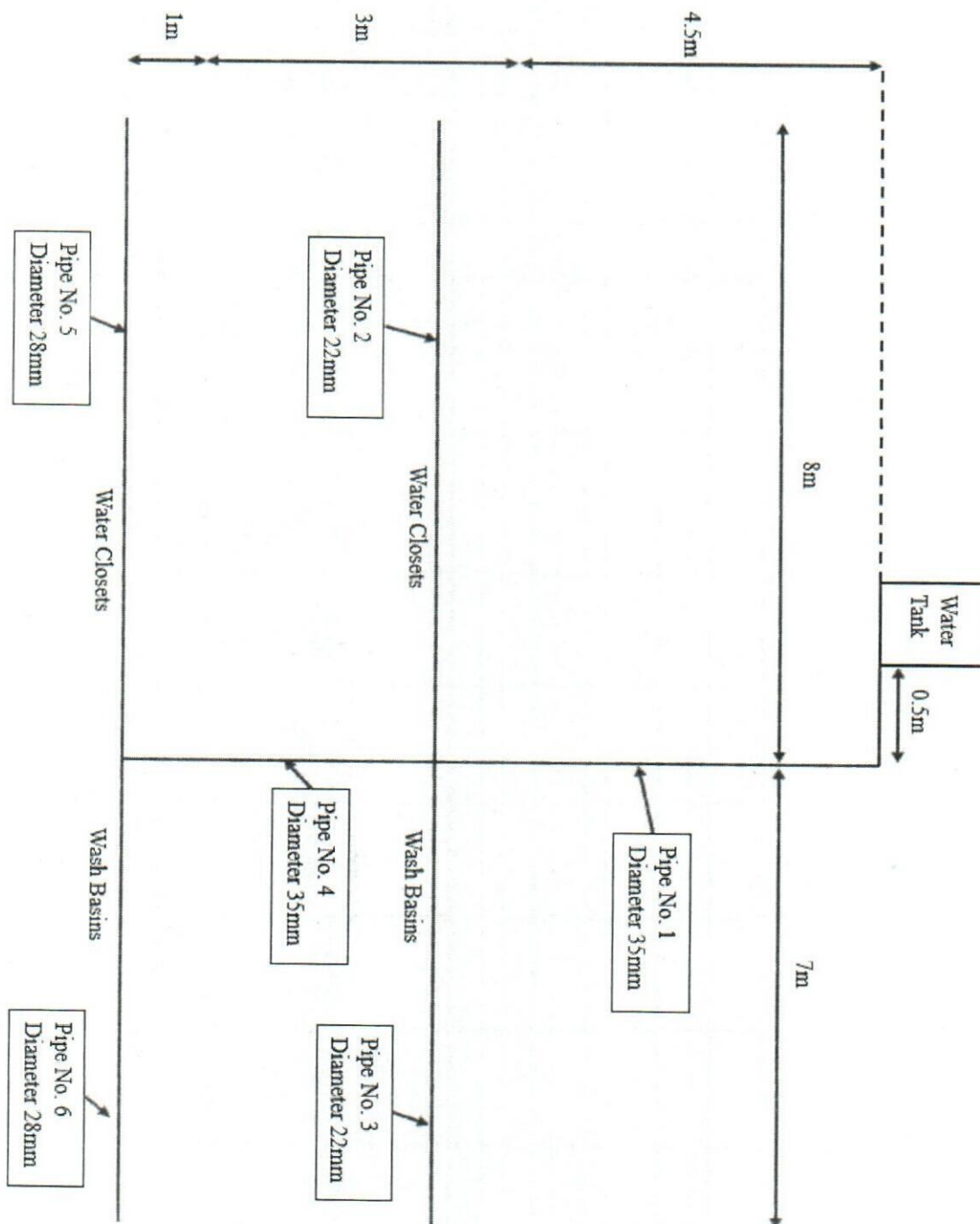


Figure Q4 : Plan view of the computer laboratory

ATTACHMENT 1 [Question 3) f) iv] – INDEX NO
 (Please make sure to attach this to the answer booklet)



ATTACHMENT 2 [Question 3) f) v] – INDEX NO
 (Please make sure to attach this to the answer booklet)

Pipe Number	Loading Units	Flow Rate (Liters/s)	Assumed Pipe Diameter (mm)	Measured Pipe Run (m)	Length of Pipe Equal To All Resistances (m)	Effective Pipe Length (m)	Loss of Head (m/m run)	Head Consumed (m)	Total Head Consumed (m)	Head Available at the Point of Discharge (m)	Final Pipe Diameter (mm)
1			35								
2			22								
3			22								
4			35								
5			28								
6			28								

ATTACHMENT 3 [Question 4)c)i] – INDEX NO
 (Please make sure to attach this to the answer booklet)

No	Item	Remark	Unit	Quantity	Factor 90° F (Btu/hr)	Factor 95° F (Btu/hr)	Load (Btu/hr)
1	Windows exposed to sun	N or E	Sqft		42	47	
		NW	Sqft		77	80	
		W	Sqft		85	100	
		NE & SW	Sqft		57	60	
2	All other windows not included above		Sqft		20	25	
3	Wall exposed to Sun	Light construction	Lft		60	70	
		Heavy construction	Lft		40	50	
4	All exterior walls not included in item 3		Lft		22	27	
5	All interior walls adjacent to an unconditioned space		Lft		20	30	
6	Ceiling or roof	Ceiling with unconditioned space	Sqft		1	3	
		Ceiling with no insulation	Sqft		8	10	
		Attic space with insulation	Sqft		5	3	
		Flat roof with no insulation	Sqft		7	8	
		Ceiling below with insulation	Sqft		3	3	
7	Floor over unconditioned space	Roof with no insulation	Sqft		14	16	
8	People		No		2	3	
9	No of Lights/electrical equipment		W			1000	
						3.4	
10	Doors and Arches continuously open to unconditioned space		No			250	
Total Cooling Load							

Appendix 1

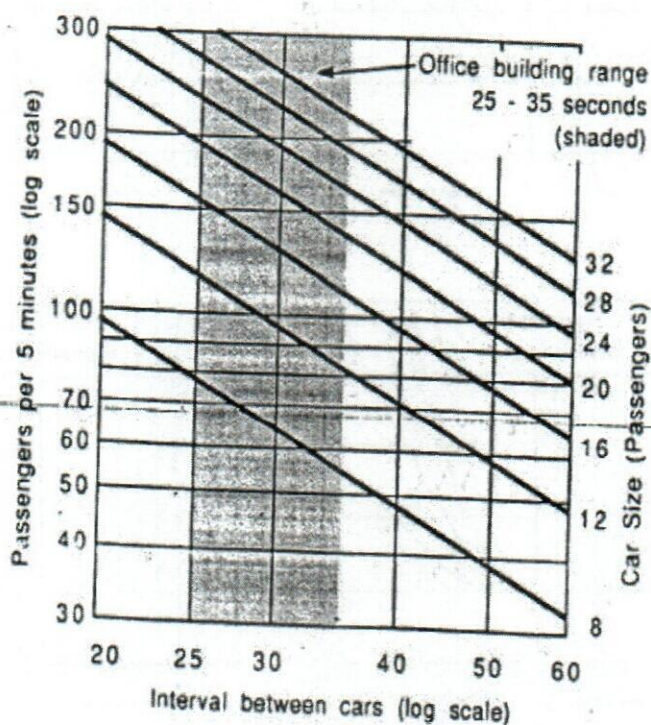
Elevator Speeds for Various Occupancies

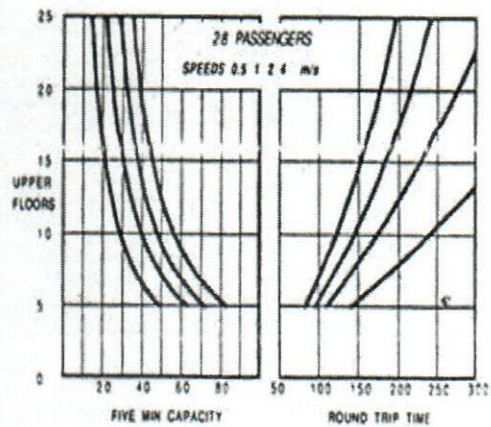
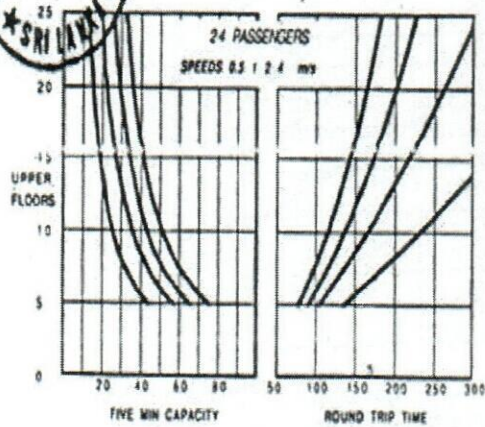
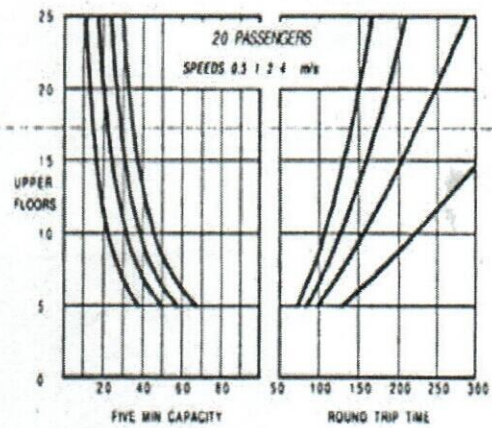
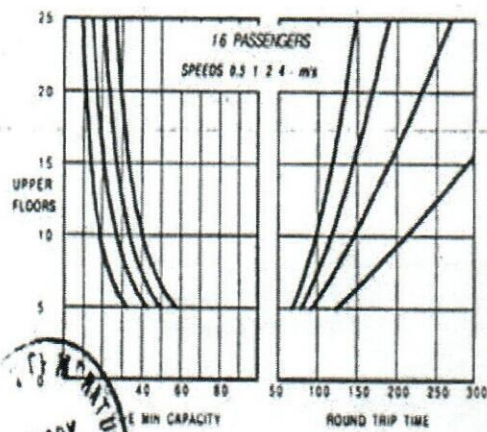
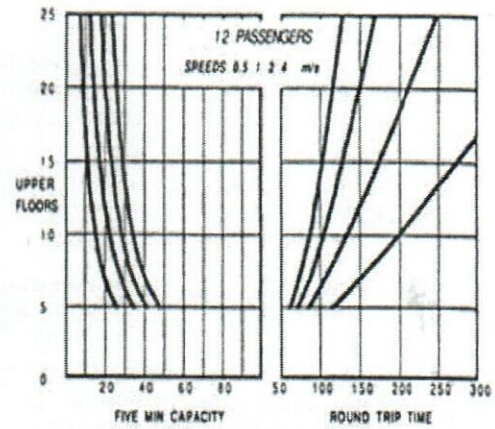
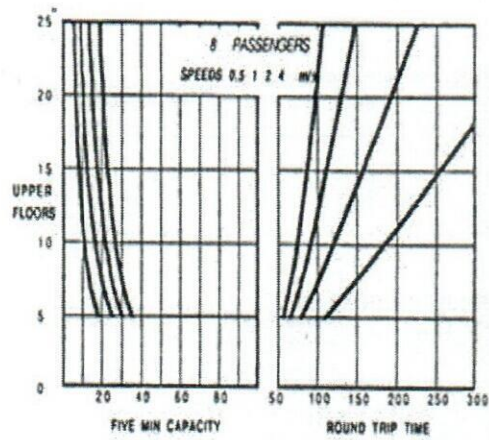
Travel Distance		Offices and Hotels		Retail Stores		Apartments	
ft	m	fpm	m/s	fpm	m/s	fpm	m/s
0-60	0-20	200-400	1-2	200	1	100	0.5
60-120	20-36	300-400	1.5-2	200-300	1-1.5	200	1
120-240	36-72	500-600	2.5-3	200-400	1-2	200-400	1-2
240-500	72-150	800-1000	4-5				

fpm: feet per minute

Design Parameters for Elevators

Building type	Design Parameters for Elevators		% Population Handled in 5 minutes	Average Interval Seconds
	Population Density ft ² /person	m ² /person		
Offices				
Prestige, single tenant	300	12	12-17	25-30
Investment downtown	100-110	9-10	12-14	30-35
Investment suburban	90-100	8-9	12-14	30-45
Apartment				
Prestige	1.5 per bedroom		5-7	50-70
Midrange	2 per bedroom		6-8	60-80
Low rental	2-3 per bedroom		6-8	80-120
Hotels				
4-5 star	1.5-2 per room		12-15	40-60
3 and less star	1.5-2 per room		10-12	50-70





Appendix 2

SLS 745 Part 2 : 2009

APPENDIX C DETERMINATION OF WORKING CAPACITY OF SEPTIC TANKS

C.1 The working capacity of a septic tank shall be the sum of the volumes required for settling, sludge digestion and sludge and scum storage and shall be estimated as follows.

C.2 The volume required for settling shall be calculated as follows.

$$V_s = t_s \cdot Q$$

Where, V_s = volume required for settling (m^3)

Q = average daily flow of wastewater (m^3/day)

t_s = time required for settling (days)
 $= (1.5 - 0.3 \cdot \log Q)$, (> 0.2) (days)

C.3 The volume required for sludge digestion shall be calculated as follows.

$$V_d = q_s \cdot t_d \cdot p$$

Where, V_d = Volume required for sludge digestion (m^3)

q_s = volume of fresh sludge per person per day ($m^3/person/day$)
 $= 0.001 m^3/p/d$ for allwaste or grey water
 $= 0.00055 m^3/p/d$ for blackwater only

and

t_d = time required for sludge digestion (days)
 $= 33$ days (for an ambient temperature of $20^\circ C$)

p = population equivalent.
 $= Q (m^3/d) / 0.2 (m^3/p/day)$ for allwaste
 $= Q (m^3/d) / 0.05 (m^3/p/day)$ for blackwater
 $= Q (m^3/d) / 0.15 (m^3/p/day)$ for greywater

C.4 The volume required for sludge storage shall be calculated as follows.

$$V_{st} = r \cdot p \cdot n$$

Where, V_{st} = volume required for sludge storage (m^3)

n = desludging interval (> 1) (years)

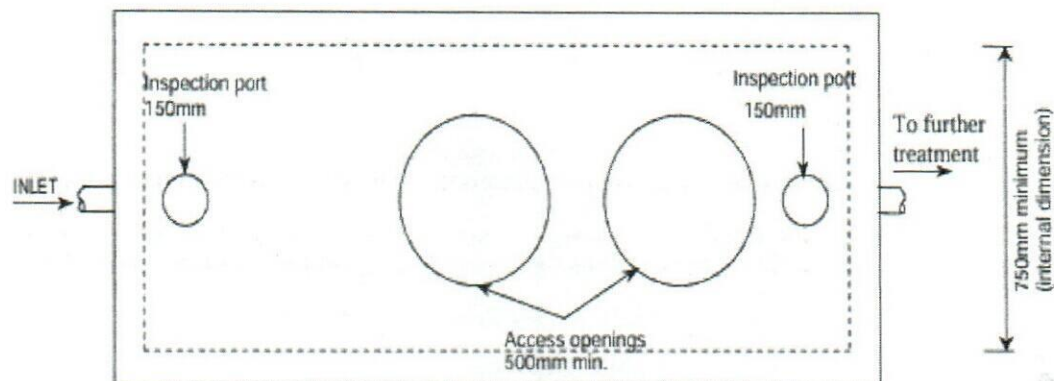
r = Volume of digested sludge per person per year ($m^3/p/y$)
 $= 0.04 m^3/p/y$ for allwaste or grey water
 $= 0.022 m^3/p/y$ for black water only

C.5 The volume required for scum storage shall be taken as $0.5V_{st}$.

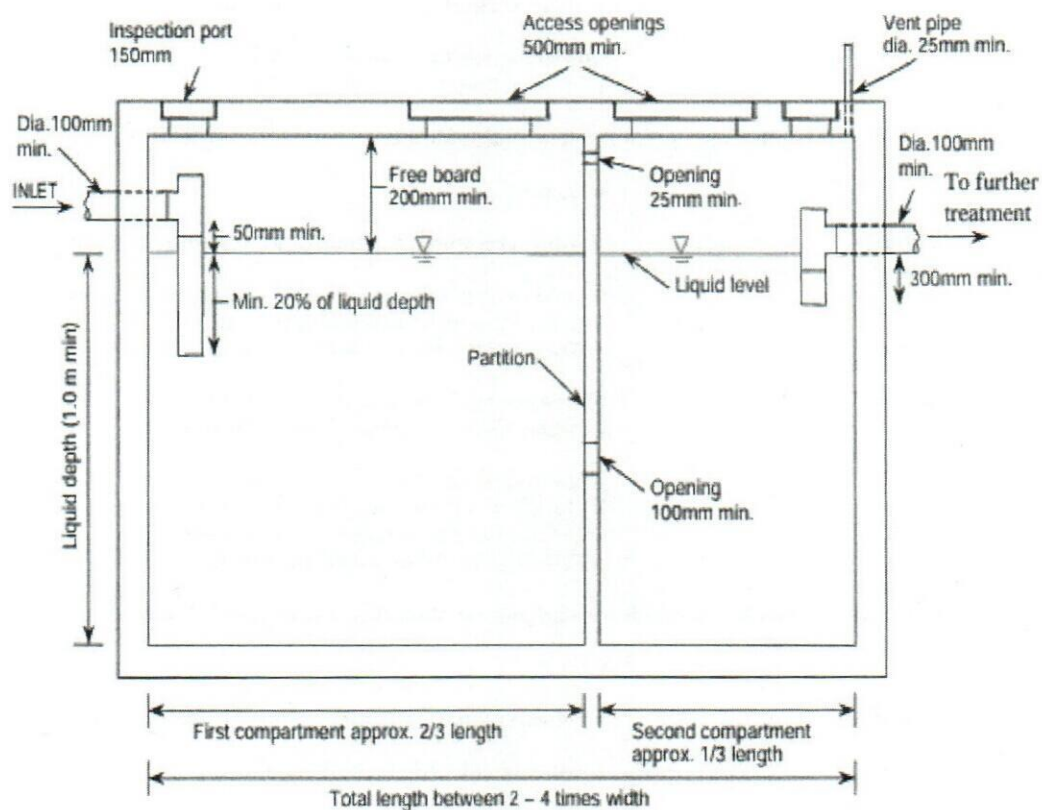
C.6 Then the design working capacity of the septic tank shall be

$$\text{Required volume, } V = V_s + V_d + 1.5V_{st} \text{ (} m^3 \text{)}$$

TYPICAL SEPTIC TANK ARRANGEMENT



PLAN



SECTION

Appendix 3

Table A3 – 1 : Required number of sanitary appliances

Planning of sanitary apartments		
Fitments	For accommodation other than for private use	
	Male personnel	Female personnel
WCs	1 for 1-15	1 for 1-12
	2 for 16-35	2 for 13-25
	3 for 36-65	3 for 26-40
	4 for 66-100	4 for 41-57
	For over 100 add at the rate of 3 percent	5 for 58-77
		6 for 78-100
		For over 100 add at the rate of 5 percent
Lavatory basins	1 for 1-15	1 for 1-12
	2 for 16-35	2 for 13-25
	3 for 36-65	3 for 26-40
	4 for 66-100	4 for 41-57
	For over 100 add at the rate of 3 percent	5 for 58-77
		6 for 78-100
		For over 100 add at the rate of 5 percent

Table A3 – 2 : Discharge unit values

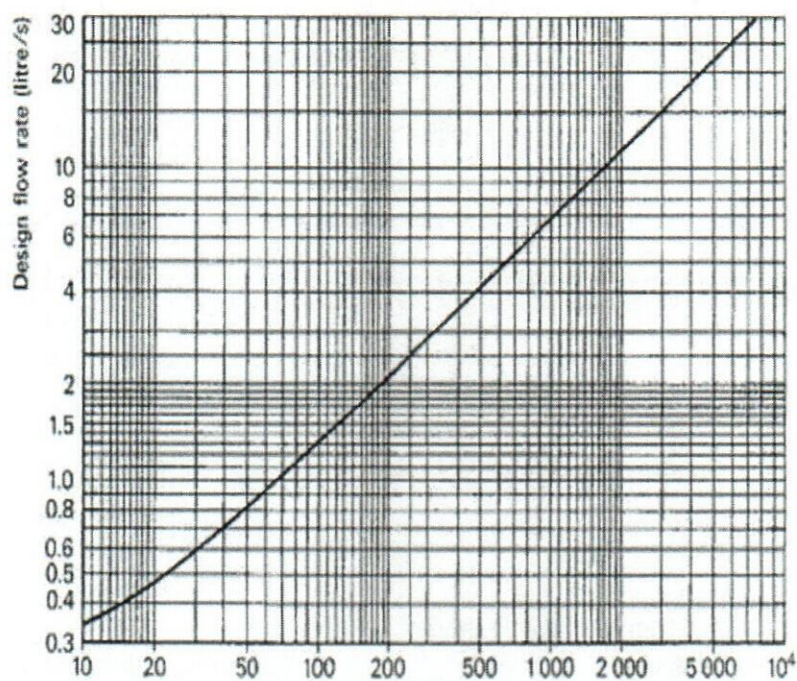
Type of appliance	Discharge unit value
Water Closet	20
Wash Basin	2

Table A3 – 2 : Maximum number of discharge units to be allowed on vertical stacks

Nominal internal diameter of pipe (mm)	Discharge units
50	20
63	80
76	200 (not more than 1 WC)
89	400
100	850
125	2700
150	6500

Table A3 – 4 : Loading unit values

Type of appliance	Loading unit value
Water Closet	2
Wash Basin	1.5

**Fig.1.1 Loading units****Table A3 – 4 : Frictional resistances of fittings expressed in equivalent pipe lengths**

Copper		
Nominal outside diameter (mm)	Metre run of pipe	
	Elbow	Tee
15	0.5	0.6
22	0.8	1.0
28	1.0	1.5
35	1.4	2.0
42	1.7	2.5
54	2.3	3.5
62	3.0	4.5
76	3.4	5.8
108	4.5	8.0

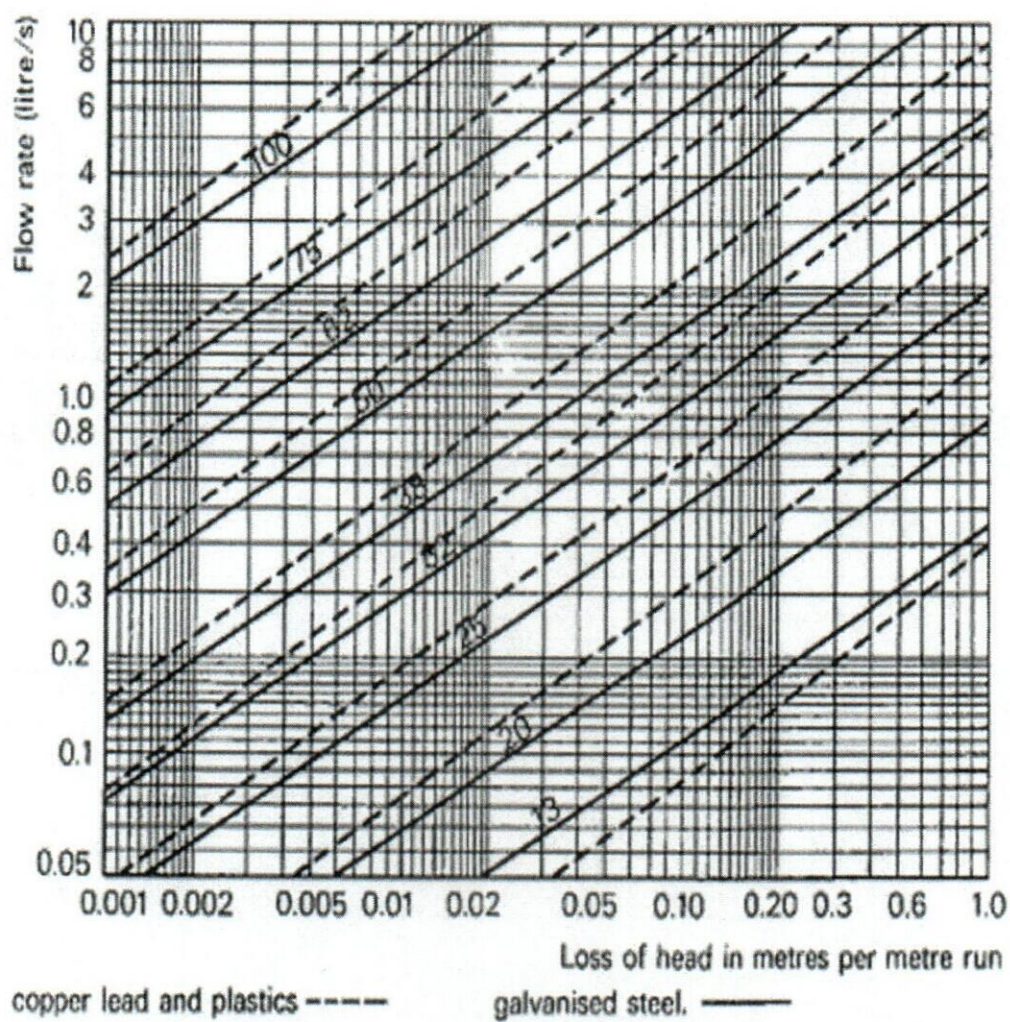
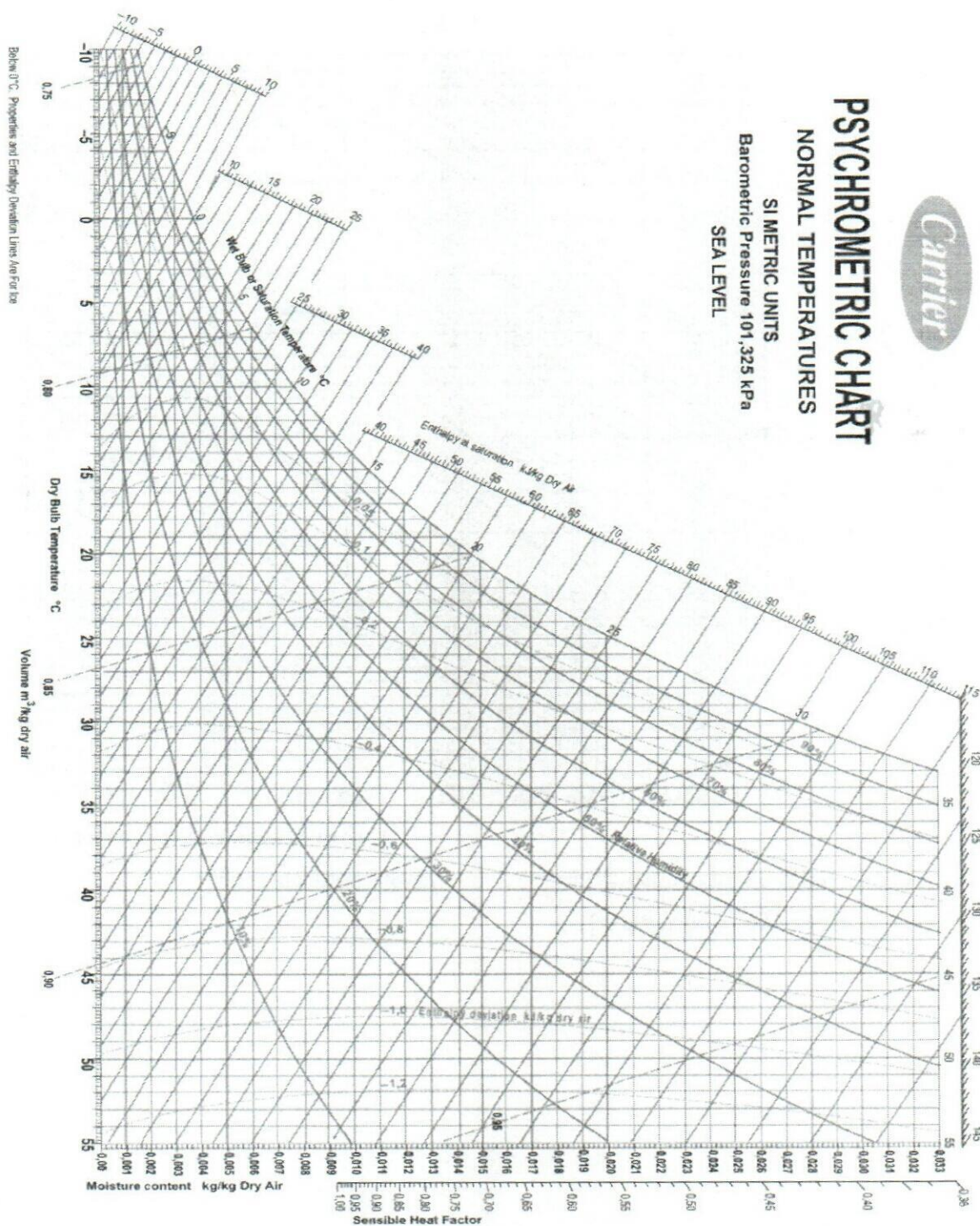


Fig.1.2 Pipe-sizing chart

A. M. S. S.

Appendix 4





Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 6 - Final Examination 2025

Module Code	:	CE3324
Module Title	:	Highway & Transportation Engineering
Date	:	23 rd June 2025
Examiners	:	Chathura Vidanapathirana
Time Allowed	:	3 hrs

Instructions to Candidates:

- This paper contains four (04) questions. Answer all four questions.
- All questions carry equal marks.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question (other than any graph sheets used) should not be scattered.
- Marks will be deducted for missing or incorrect measuring units.
- You are advised to make a clear diagram for each question, where appropriate. This will help you to perform calculations correctly.
- Assume reasonable values for any data/information not provided with the exam paper (clearly state the assumptions)
- This is an **open-book exam**, you are allowed to bring your study notes and a calculator only.
- A graph sheet will be provided.

Question 1

- i. Elaborate why space mean speed is more suitable than time mean speed in traffic studies.
[3 marks]
- ii. An AI-based technique was used to conduct a travel time and speed survey on Galle Road. Colombo direction of the road was considered first, and two enumerators were placed at two intersections (Dehiwala and Wellawatta) that are 2km apart. The data of the survey done from Dehiwala to Wellawatta are as shown in Table 1. The spot speeds of the vehicles were also measured at Dehiwala.

Table 1: Traffic survey data of the road section

License plate number	Spot speed at Dehiwala (km/h)	Observed time at Dehiwala (PM)	Observed time at Wellawatta (PM)
KD-2665	40	10:45:35	10:49:09
NF-6548	45	10:46:12	10:48:57
KK-0321	31	10:46:36	10:49:30
BI-9870	50	10:47:15	10:49:59
GS-9874	49	10:48:55	10:51:58

- a) Considering the survey data given above, determine the 'time mean speed at Dehiwala' and the 'space mean speed' of the road section in km/h.
[6 marks]
- b) Using your knowledge of traffic engineering, propose another method/technique to conduct the same traffic survey as mentioned above (i.e.: a survey to obtain travel times of vehicles on a particular road section).
[3 marks]
- iii. A traffic stream that follows the Greenshield's model, has a free-flow speed of 50 km/h. The maximum traffic density on this road is 100veh/km/lane.
 - a) Calculate the space mean speed of the traffic stream if the density is 50veh/km/lane.
[4 marks]
 - b) Calculate the flow rate of the scenario mentioned in Q1-iii-a.
[3 marks]
 - c) If the condition of the **same** traffic stream changes and the new space mean speed is 15km/h, determine the new traffic density?
[3 marks]
 - d) Calculate the traffic flow rate of the scenario mentioned in Q1-iii-c
[3 marks]

Question 2

- i. Discuss why the deterministic queuing model is more suitable when the arriving traffic flow is high at an automated expressway toll gate. State your arguments clearly. [3 marks]
- ii. The ticketing counter at a cinema has one booth which is operated manually. The time taken by the operator to issue a ticket to a person is 1 minute. The cinema opens the ticketing counter at 5 p.m. and people start queuing up in a single channel. Till 5:30 p.m., the arrival rate of people per hour is 120. After 5:30 p.m. the rate drops to 30 per hour. All the given rates are constant and uniform. The movie starts at 6 p.m.
- a) Describe why the above scenario can be analysed using the D/D/1 method. Clearly mention your arguments. [2 marks]
- b) Illustrate the situation at the ticketing counter on a graph. [7 marks]
- c) Identify the point of dissipation of the queue on the graph and state the time. [2 marks]
- d) What is the maximum individual delay experienced by a person? [2 marks]
- e) What is the maximum queue length observed during the queuing phase? [2 marks]
- f) Calculate the total system delay during the queuing phase. [3 marks]
- g) Determine the average queue length and average delay per vehicle [3 marks]
- h) How many people entered the cinema hall after the movie has started [1 mark]

Question 3

A Policy on Geometric Design of Highways and Streets: 5th edition, 2004 published by American Association of State Highway and Transportation Officials (AASHTO) is the preferred standard for this question.

- i. An expressway section on a flat terrain is being designed for its geometry. The design speed of the road is 140km/h. The standards recommend a superelevation of 12% for high-speed expressways and the road should be constructed with a bituminous surface.
 - a) Propose a suitable radius for the horizontal curves of this expressway if the surface has a lateral friction coefficient of 0.128.

[3 marks]

- b) Calculate the stopping sight distance required under the given conditions. Assume that the drivers have a perception/reaction time of 1.8 seconds. The deceleration rate of a typical car is 4.9m/s^2 . The gravitational pull can be assumed as 9.8m/s^2 .

[4 marks]

- c) On slippery conditions, a car crashed onto a side barrier of this road after losing control. The analysts predicted an impact speed of 50km/h. If the effective longitudinal friction is 0.3 under slippery conditions, how far did the car skid after applying breaks if it was initially travelling at a speed of 120km/h?

[4 marks]

- d) Comment on why there are multiple sight distance categories defined instead of one common sight distance.

[3 marks]

- ii. Considering the design value of stopping sight distance (SSD), determine the length of a crest curve that is required to connect the two grades: $G1 = 2.5\%$ and $G2 = -2.5\%$. Assume the design speed of the road as 70km/h. For a passenger car, the height of eye above roadway surface is typically 1080mm and the height of object above roadway surface is 600mm.

[4 marks]

- iii. The answer obtained in Q3-ii is suitable for passenger cars. However, for heavy vehicles such as trucks, buses, and large lorries, this curve length may not be adequate as they

require comparatively more time to stop the vehicle (due to inertia and low deceleration rate). Hence, their SSD requirement is also high. If the vertical curves are designed using 'passenger car' as the basis, how would the roads still be safe for heavy vehicles?

[4 marks]

- iv. The distance covered by a typical head light beam of a vehicle is 120m. A vertical sag curve joining a -2.5% gradient with a +2.5% gradient has to be designed to suit a design speed of 80km/h. Determine the required length of the sag curve.

[3 marks]

Question 4

Overseas Road Note 31: A guide to the structural design of bitumen surfaced roads in tropical and sub-tropical countries 4th edition is the preferred standard for the following question.

- i. A two-lane two-way highway needs to be provided with a new pavement since the current layers have significantly deteriorated. In the road rehabilitation programme, a survey was conducted to propose a new pavement design. The daily traffic volumes of each direction of the road are given in Table 2 along with the Equivalent Single Axel Load (ESAL) factors. A bituminous material is preferred for the surface layer. There should be suitable sub-layers providing the structural requirements of the pavement.

The design life of the road has to be decided by the engineer. The yearly growth rate of the traffic on this road is 3%. The soil investigation report suggests a California Bearing Ratio value of 7% for the sub grade.

Table 2: Traffic volumes and ESAL factors

Vehicle type	Direction 01		Direction 02	
	Daily volume	ESAL factor	Daily volume	ESAL factor
Motorcycle	1,546	0.000002	1,234	0.000002
Three-wheeler	1,654	0.000013	1,698	0.000013
Car and SUV	1,398	0.000030	1,574	0.000030
Van	654	0.000040	564	0.000040
Large Bus	140	2.950000	120	2.950000
Light Goods Vehicle	420	0.325000	380	0.325000
Medium Goods Vehicle	200	3.200000	235	3.200000
Heavy Goods Vehicle	34	8.000000	26	8.000000

a) Propose the most appropriate design life period for this highway?

[2 mark]

b) Consider the survey data and provide a justifiable design for the pavement.

[13 marks]

c) Mention the vehicle categories included in the calculations of Q4-i-b. Justify your selection.

[3 marks]

ii. Write a short essay on ONE of the following topics (250-300 words)

a) The economic implications and impacts of a good road network

b) A flyover is the least preferred intersection control mechanism

c) Developed countries favour public transport instead of personal vehicles

[7 marks]



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 8 -Final Examination 2025

Module Code : CE4321
Module Title : Construction Engineering & Management
Date : 25th June 2025
Examiners : Eng. Kushan Hirimuthugoda
Time Allowed : 3 hrs

Instructions to Candidates:

- This is an open book exam.
- This paper consists of two parts. Part A and Part B. Answer all questions from Part A and Part B.
- Use the Same booklet to answer Part A
- Suggested time period for Part A is 80 minutes and Part B is 100 minutes
- Use only the answers booklet, additional papers, and graph paper for your answers provided by the exam department.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question (other than any graph sheets used) should not be scattered.
- If You have any doubt regarding the interpretation of the wording of a question, make your own assumptions and clearly state it on the answer script.

Part A

1. Installing an assembly line in a toy factory is a;
 - a. Project
 - b. Process
 - c. Operation
 1. a only
 2. b only
 3. c only
 4. a and b only
 5. b and c only
2. Which of the following statements are TRUE about productivity?
 - a. The main objective of work study is to improve productivity of workers, machines and materials
 - b. Predetermined Motion Time System (PMTS) is NOT a work measurement technique that analyzes the basic human movements
 - c. Work study helps to find the best method of performing by eliminating wastages
 1. a only
 2. a and b only
 3. a and c only
 4. b and c only
 5. All
3. Which of the following statements of FALSE regarding construction machines?
 - a. Forklift can lift one or few workers
 - b. Asphalt paving machine provides minor compaction before it is compacted by a roller
 - c. From a tunnel boring machine a specific excavation profile can be achieved
 1. a only
 2. b only
 3. c only
 4. a and b only
 5. b and c only

4. Which of the following statements are TRUE;
- Contracts can be formed within the family, over the family matters
 - To Form a contract, it should always have a written document
 - Sometimes only one party is liable for making a contract
 - a only
 - b only
 - c only
 - a and b only
 - b and c only
5. In a project the selected main contractor has to provide services needed by the nominated subcontractors and to do the coordination with them. For that the main contractor is paid with;
- Nominated fee
 - Subcontractor fee
 - Nominated sub-contractor fee
 - Attendance fee
 - Coordination fee
6. You are managing a project that has a To-complete performance index (TCPI) of 0.98 What is the BEST course of action?
- You're under budget, so you can manage costs with lenience
 - Manage costs aggressively
 - Create a new schedule
 - Create a new budget
 - Not Enough Data
7. In which item of a BOQ describes the costs that cannot be apportioned in to measured work
- Preliminaries
 - Preambles
 - Provisional Sums
 - Contingencies
 - Measured Works

8. Which of the following is TRUE about Near Miss?
- It is also known as Near Hit
 - It is an accident result in injury or damage
 - A Near Miss today can be tomorrow's accident
- a only
 - b only
 - c only
 - a and b only
 - a and c only
9. If you have a commercial dispute of Rs. 6,000,000.00 of a contract you signed with your client in which of the following courts you can file a case;
- Commercial High Court
 - Civil High Court
 - Magistrate Court
- a only
 - b only
 - c only
 - a and b only
 - a and c only
10. You are managing a project with a Budget at completion (BAC) of Rs. 93,000.00, Earned Value (EV) of Rs. 39,870.00, Planed Value (PV) of Rs. 64,800.00 and Actual Cost (AC) of Rs. 44,200.00. What is the Cost Performance Index (CPI)?
- 1.5
 - 0.9
 - 1.2
 - Rs. 9,000.00
 - Rs. 1.2
11. You are a project manager for a construction project and you work with your own work force of the company. But for electrical and plumbing works you do not have competent skill workers on the company. Because of that you are going to hire some subcontractors for that specific job. This is called;
- Outsourcing
 - Referrals
 - Walk ins
 - Head Hunting
 - Offshoring

12. You are doing the Vendor Bid Analysis. Which Process Are you in?
1. Determining Budget
 2. Controlling Costs
 3. Estimating Costs
 4. Cost Baseline
 5. Cost Evaluation
13. Which one of the following is NOT an advantage of an orientation program?
1. It helps to understand about the organization
 2. Feels welcome
 3. Can get an idea about what is expected in work and behavior
 4. Gives technical knowledge on what to do
 5. It helps to start the socialization process
14. If Actual Cost (AC) is lower than your Earned Value (EV), what does this mean
1. The project is under budget
 2. The project is over budget
 3. The project is ahead of schedule
 4. The project is behind schedule
 5. Not enough data
15. If a worker is working at height with the full safety harness belt and lanyard of 6 feet length what should be the minimum height of the anchorage point to the floor level. Take height of the worker as 6 feet and safety factor as 3 feet and maximum deceleration distance as 3 feet.
1. 16.5ft
 2. 17.0ft
 3. 17.5ft
 4. 18.0ft
 5. Not enough data
16. Planned budget is a snapshot of.....
1. Life Cycle Costing
 2. Internal Rate of Return (IRR)
 3. Cost Baseline
 4. Earned Value (EV)
 5. Benefit Cost Ratio (BCR)

17. When you are using MS project software to make Gantt chart what is the sequence that you use to complete it
- Define the project
 - List the tasks in the project
 - Define general working time
 - Schedule tasks
 - Organize task into phases
- a $\Rightarrow$ b $\Rightarrow$ c $\Rightarrow$ d $\Rightarrow$ e
 - a $\Rightarrow$ c $\Rightarrow$ b $\Rightarrow$ d $\Rightarrow$ e
 - a $\Rightarrow$ c $\Rightarrow$ b $\Rightarrow$ e $\Rightarrow$ d
 - a $\Rightarrow$ b $\Rightarrow$ c $\Rightarrow$ e $\Rightarrow$ d
 - a $\Rightarrow$ c $\Rightarrow$ d $\Rightarrow$ b $\Rightarrow$ e
18. Which of the following is NOT a method that you can use to Plan the Quality management process of your company
- Completed check lists
 - Benchmarking
 - Standardization
- a only
 - b only
 - c only
 - a and b only
 - a and c only
19. Which of the following statements are FALSE about earth moving machines?
- A Scraper is generally carried out on a downward gradient to take full advantage of gravity
 - If the mould board can be tilted in the horizontal and vertical planes in a Dozer, then the machine is called an angle dozer
 - Front Shovel pulls the material towards the machine
- a only
 - b only
 - c only
 - a and b only
 - a and c only

20. Which of the following business organizations will NOT protect the owner's assets in the event of business fault or accident?
- Limited Liability
 - Sole Proprietorship
 - Partnership
- a only
 - b only
 - c only
 - a and b only
 - b and c only
21. Which of the following is FALSE about legal system in Sri Lanka?
- By Laws are regulations made by a local authority or corporation
 - Legislation is an act passed by the supreme court
 - The existing constitution of Sri Lanka has been formally amended 21 times as October 2022
 - Roman Dutch Law is the common law of our country
 - Judicial Precedent is called judge made law
22. You are a project manager of a site and you are asked to do a performance appraisal of a supervisor for the last year. You do it based on his work performance in the previous month only. Because of this that performance appraisal fails. This is called;
- Halo effect
 - Central Tendency
 - Leniency
 - Bias
 - Recency error
23. Which is FALSE about organization structures?
- Flat organizations are also described as self-managed
 - Flat organizations are delay decision-making processes
 - Functional Organizations Divides a firm's operations based on specialties
 - In a Matrix organization there is more than one line of reporting managers
 - In Matrix organizations, the employees are accountable to more than one boss

24. You are a newly appointed engineer for a construction project. From the first day you have been given lot of responsibilities, without telling the procedures to follow. Because of this you are very stressed and now you are thinking of leaving the company. what is the Feyol's Management Theory that your company should follow to retain you
1. Unity of command
 2. Unity of direction
 3. Scalar chain
 4. Order
 5. Stability of tenure personnel
25. Which of the following statements are FALSE about soil compaction?
- a. In the case of large lift thickness, bridging may occur at the top of lifts
 - b. When the soil starts to crack, it means you need some more roller passes
 - c. At site you use 75% of the ideal maximum lift thickness provided by the machine manufacturer
1. a only
 2. b only
 3. c only
 4. a and b only
 5. b and c only
26. Which of the following are fundamental element of a contract?
- a. Legality of objects
 - b. An offer and an acceptance
 - c. Capacities of parties
1. a only
 2. a and b only
 3. a and c only
 4. b and c only
 5. All
27. What is the ISO standard for management systems of Occupational Health and Safety (OHS)?
1. ISO 45001
 2. ISO 27001
 3. ISO 18001
 4. ISO 9001
 5. ISO 9000

28. You are doing the Vendor Bid Analysis. Which Process Are you in?
1. Determining Budget
 2. Controlling Costs
 3. Estimating Costs
 4. Cost Baselineing
 5. Cost Evaluation
29. Which of the following statements are TRUE;
- a. Crashing the project adds risk, while fast-tracking adds cost
 - b. Crashing the project adds cost, while fast-tracking adds risk
 - c. When you crash a project, it always shortens the total duration of the project
1. a only
 2. b only
 3. c only
 4. a and b only
 5. b and c only
30. Your company has asked you to provide a cost estimate that includes maintenance, installation, support, and upkeep costs for as long as the product will be used. What is that kind of estimate called?
1. Benefit-cost ratio
 2. Depreciation
 3. Net present value
 4. Lifecycle costing
 5. Earned value management
31. Which of the following is FALSE about a Functional Organization?
1. Work is performed more efficiently since each manager is responsible for a single function
 2. The employees are accountable to more than one boss
 3. Delay in decision-making
 4. Divides a firm's operations based on specialties and there's an individual in charge of a particular function
 5. There's a total specialization of work

32. Which of the following are TRUE regarding individual's response for change?
- People always motivated with the change
 - People sometimes get new opportunities with change and they think it will be better
 - People can be confused and scared
- a only
 - a and b only
 - a and c only
 - b and c only
 - All
33. Which of the following Techniques that you can use to Manage Quality?
- 5S
 - Three MU's
 - Standardization
- a only
 - a and b only
 - a and c only
 - b and c only
 - All
34. In the Law case of Harvey v Facey, what fundamental element of contract of was considered in giving the judgement
- An Offer
 - An Acceptance
 - Genuineness of Consent
 - Certainty of terms
 - Intention
35. Which of the following is TRUE about Productivity?
- Productivity is a measure of performance that compares the output of a product with the input, or resources, required to produce it
 - Productivity can be measured always
 - When production increases, productivity always increases
- a only
 - a and b only
 - a and c only
 - b and c only
 - All

36. Which of the following is TRUE about Activity Sampling?

- a. This technique provides rapid and effective means of studying the pattern of almost any type of activity
- b. The process of collecting information about machine or human activities by making a large number of instantaneous observations of the subject
- c. The degree of confidence and accuracy in the result cannot be varied
 - 1. a only
 - 2. a and b only
 - 3. a and c only
 - 4. b and c only
 - 5. All

37. During the Bid evaluation process a Bid can be rejected due to;

- a. There are calculation errors in the BOQ
- b. Contract has not provided the required Bid security
- c. Contractor has not signed the Form of Bid properly

Which of the above are TRUE?

- 1. a only
- 2. a and b only
- 3. a and c only
- 4. b and c only
- 5. All

38. When you go to the job for the first time you find that your company is having different departments for different functions such as Engineering, Procurement, Finance, Human Resources. You have a project manager who is handling your project also. You need to report to the Project Manager at site and also to the Engineering manager at head office. The organization structure at your company is highly likely;

- 1. Flat Organization
- 2. Functional Organization
- 3. Divisional Organization
- 4. Matrix Organization
- 5. Not enough data

39. When selecting a new project manager for a construction project you should NOT consider this;

1. Gender
2. Knowledge
3. Skills
4. Abilities
5. Previous experience in similar projects

40. Key Performance Indicators (KPI) Can be used to improve;

- a. Quality in Construction
- b. Productivity in Construction
- c. Time efficiency in construction

1. a only
2. a and b only
3. a and c only
4. b and c only
5. All

(1.25x40=50 Marks)

Part B

1. Develop a Logic Network (Network Diagram) for the sequence of activities listed in the table. Calculate Early Start (ES), Early Finish (EF), Late Start (LS), Late Finish (LF) time and float for all activities. Find the Critical Path and duration for the critical path

Activity	Duration(Weeks)	Predecessor
Start	0	None
A	4	Start
B	3	A
C	4	A
D	2	B and C
E	3	C
F	1	D
G	4	D and E
H	3	F and G
I	2	H

2. "Green Build Construction Ltd." is a company specializing in residential building projects. Recently, they have been experiencing delays in completing their projects on time. The management has noticed that some projects take longer than initially planned, and costs are higher than expected. Recently, the company faced several challenges:
- A new government regulation requires the use of environmentally friendly materials, which are more expensive and less readily available.
 - The industry is experiencing a labor shortage due to increased construction activities nationwide.
 - Internally, the company has outdated machinery and inefficient project management practices

Based on the scenario explain the factors affect "Green Build Construction Ltd." For their productivity and how they can overcome them

3. You are the Human Recourse (HR) manager of a construction company. You are asked to hire a new senior project manager for a new upcoming project. Instead of hiring a new one you have suggested to appoint a junior project manager who is performing well. Discuss advantages and disadvantages of hiring an internal candidate (**Discuss three advantages and three disadvantages**)

4. You are a newly appointed safety officer of a pilling company. You are going to start a pilling job for a multi-story building. You need to identify **Two** safety hazards that can happen at each the following stages of the site progress and the safety measures that you can take to avoid them.

- i. Site planning
- ii. Site Mobilizing
- iii. Pilling boring and concreting
- iv. Pile Hacking

5. "Urban Build Ltd." has been awarded a contract to construct a large commercial office building in the city. The project has a tight schedule and a fixed budget set by the client. As the project progresses into the initial phases, the project manager notices that costs are starting to exceed the planned budget. Several factors, such as fluctuating material prices, unforeseen site conditions, and minor scope changes, have contributed to this situation.

The project manager wants to implement effective strategies to control costs and avoid further overruns. They recognize the importance of accurate planning, good communication, and proactive management to keep the project financially on track

With the knowledge you gain during the university advice the project manager how you can do the cost management for "Urban Build Ltd." Explain your answer

(10x5=50 Marks)

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CE3322

Final examination

Geotechnical Engineering



Faculty of Engineering & Technology
Department of Civil Engineering
BSc Hons (Eng) Civil Engineering
Semester 6 -Final Examination 2025

Module Code : CE3322
Module Title : Geotechnical Engineering
Date : 18th June 2025
Examiners : Supun Walpita
Time Allowed : 3 hrs

Instructions to Candidates:

- This is a **closed book** examination
- This paper consists of Three (03) questions. Answer **all three** questions.
- Use only the answers booklet, additional papers and graph paper for your answers.
- Write clearly and legibly with a blue or black pen.
- Write your name and student number on all sheets.
- Answers to different parts of the same question (other than any graph sheets used) should not be scattered.
- Marks will be deducted for missing or incorrect measuring units.
- You are advised to make a clear diagram for each question, where appropriate. This will help you to perform calculations correctly.
- If You have any doubt regarding the interpretation of the wording of a question, make your own assumptions and clearly state it on the answer script.

1)

- a) **Figure 1** given below shows details of an embankment made of cohesionless soil with $\phi = 34^\circ$ and the unit weight of the soil is 18 kN/m^3 .

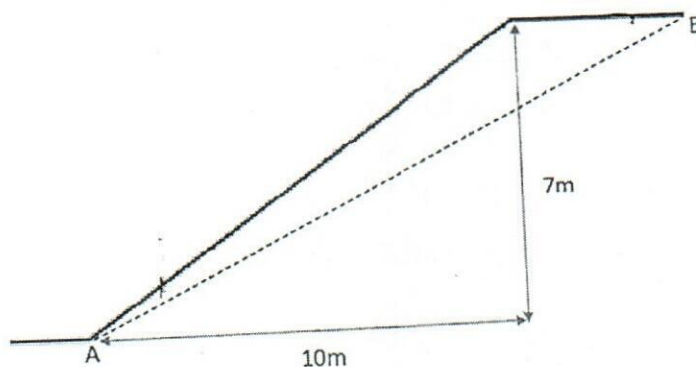


Figure 1

- I. Determine the factor of safety against sliding. (4 marks)
- II. Line AB in the diagram shows a cut made in to the slope to improve the factor of safety to 1.3. If the length of slope in longitudinal direction is 20m, then find the weight of soil to be excavated. (8 marks)

- b) A rock face whose orientation 235/50NW is intersected by two joint sets with orientations 195/40NW and 220/35NW. Assume the angle of friction as 30°
- I. Plot the slope face and joint sets using stereographic projection (9 marks)
 - II. Discuss the possibility of a wedge failure (5 marks)

2)

- a) An 8m high soil profile is shown in **Figure 2**, to be supported by a retaining wall.

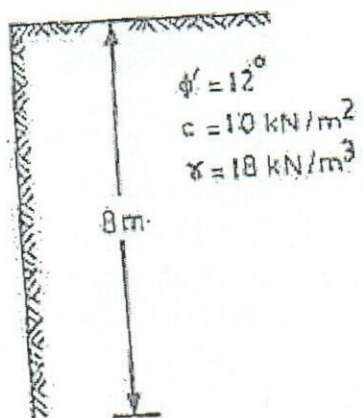


Figure 2

- I. Explain the term "tension crack ". (4 marks)
- II. Calculate the depth of a potential tension crack (6 marks)
- III. Determine the active earth pressure exerts on the bottom of the wall & total active force per meter length of the wall (8 marks)

- b) Using the following data, analyze the stability of the gravity retaining wall given in **Figure 3** (Use Design combination A1 +M1+R1) (22 marks)

Unit weight of the concrete = 24 kN/m^3

Unit weight of soil = 18 kN/m^3

Angle of shearing resistance for soil = 38°

Cohesion of soil = 0

Bearing Capacity of soil = 200 kN/m^2

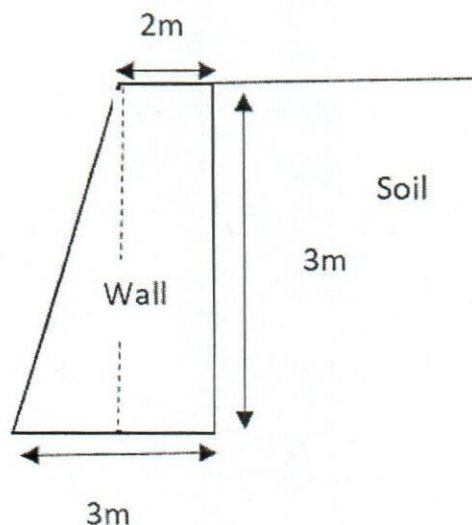


Figure 3

- c) Suppose that the retaining wall shown in Figure 3 is constructed with the slanted/inclined face towards the backfill. Discuss how this will affect the lateral thrust on the wall and stability considerations, sliding, overturning and bearing failure, providing adequate reasoning (6 marks)

- 3)
a) Discuss the short-term and long-term stability of a slope with reference to soil strength and pore water pressure. Support your discussion with relevant diagrams where appropriate. (8 marks)
- b) Investigate the stability of the embankment shown in **Figure 4**. The embankment consists of granular fill (Soil A) placed upon a deep deposit of clay (Soil B). Both soils have a bulk unit weight of 19 kN/m^3 . The fill has $\phi' = 30^\circ$ & $c' = 5 \text{ kPa}$ while the clay deposit has $\phi' = 10^\circ$ & $c' = 30 \text{ kPa}$. **Table 1** provides the details relevant to individual slices (20 marks)

Table 1

Slice No.	Area (m ²)	Width (m)	α°
1	8.00	2.0	40
2	14.00	3.5	32
3	18.00	3.3	15
4	21.00	3.8	0
5	3.00	2.3	12

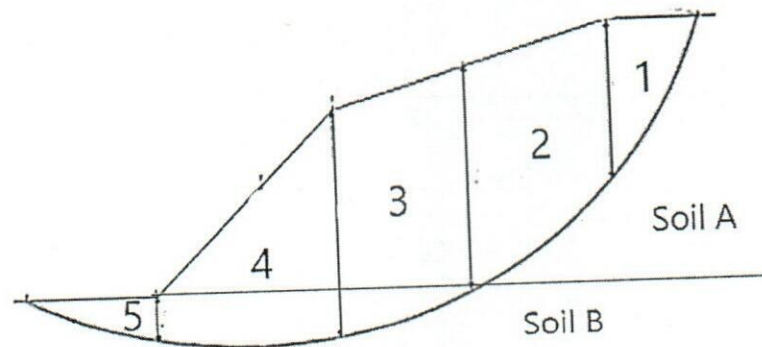


Figure 4

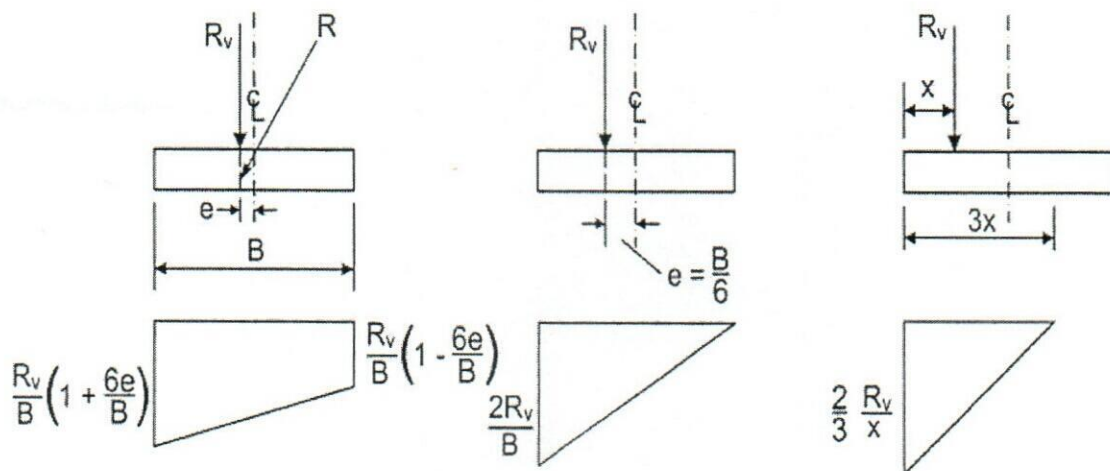
- End of Questions -

Additional Data

$$F = \frac{\sum c l + \sum N \tan \phi}{\sum T}$$

$$p_a = \sigma_z k_a - 2c \sqrt{k_a}$$

$$F = \frac{1}{\sum W \sin \alpha} \sum [c' l + (W \cos \alpha - ul) \tan \phi']$$



Partial factor sets for EQU, GEO and STR limit states.

GEO/STR – Partial factor sets									
Parameter	Symbol	EQU	A1	A2	M1	M2	R1	R2	R3
Permanent action (G)	$\gamma_{G,dead}/\gamma_{G,unif}$	1.1	1.35	1.0					
	Favourable	0.9	1.0	1.0					
Variable action (Q)	$\gamma_{Q,stab}/\gamma_{Q,lev}$	1.5	1.5	1.3					
	Unfavourable	–	–	–					
Accidental action (A)	Favourable	1.0	1.0	1.0					
	Unfavourable	–	–	–					
Coefficient of shearing resistance ($\tan \phi'$)	$\gamma_{\phi'}$	1.25			1.0	1.25			
	Effective cohesion (c')	1.25			1.0	1.25			
Undrained shear strength (c_u)	γ_{c_u}	1.4			1.0	1.4			
Unconfined compressive strength (q_u)	γ_{q_u}	1.4			1.0	1.4			
Weight density (γ)	γ_γ	1.0			1.0	1.0			
Bearing resistance (R_b)	γ_{R_b}						1.0	1.4	1.0
Sliding resistance (R_h)	γ_{R_h}						1.0	1.1	1.0
Earth resistance (R_d)	γ_{R_d}						1.0	1.4	1.0

Note: weight density $\equiv$ unit weight.

