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Faculty of Engineering & Technology

Department of Civil Engineering

Bachelor of Science Honours in Engineering

Year 1 Semester 2 Final Examination 2025

Module Code	:	**CE1322**
Module Title	:	**Fluid Mechanics**
Date/Time	:	**10th May 2025 / 09.00 am –12.00 pm**
Examiner	:	**L. S. Ranasinghe**
Time Allowed	:	**Three hours only**

INSTRUCTIONS TO CANDIDATES

- This is a **closed book** examination
- This paper consists of 5 questions on 5 pages. Attempt **ALL** questions
- Show all stages of your work
- State all assumptions made under each question

MATERIALS REQURIED

- Answer booklet
- You may use a scientific calculator. This must not be programmable and may be inspected during the examination
- Extra answer papers (if required)
- Equations and additional information are given on the last page

Question 1

(a) What is specific gravity? How is it related to density?

(5 marks)

(b) The pressure difference between an oil pipe and water pipe is measured by a double-fluid manometer, as shown in Figure Q1-1. For the given fluid heights and specific gravities, calculate the pressure difference $\Delta P = P_B - P_A$.

(10 marks)

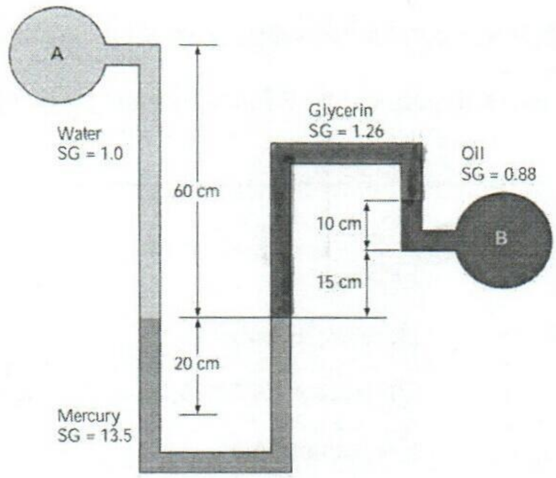

Figure Q1-1

(c) A 4 m high, 5 m wide rectangular plate blocks the end of a 4 m deep freshwater channel, as shown in Figure Q1-2. The plate is hinged about a horizontal axis along its upper edge through a point A and is restrained from opening by a fixed ridge at point B. Determine the force exerted on the plate by the ridge.

(15 marks)

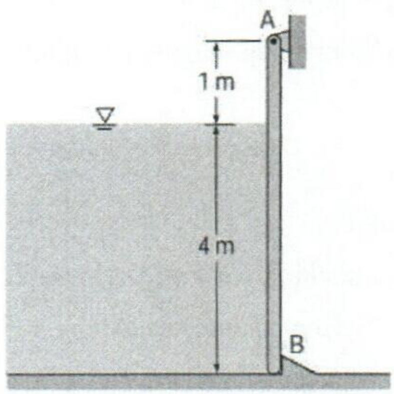

Figure Q1-2

Question 2

(a) State and discuss two practical engineering applications of Bernoulli's Principle.

(5 marks)

(b) A pressurized tank of water as shown in Figure Q2, has a 10 cm diameter orifice at the bottom, where water discharges to the atmosphere. The water level is 3 m above the outlet. The tank air pressure above the water level is 300 kPa (absolute) while the atmospheric pressure is 100 kPa. Neglecting frictional effects, determine the initial discharge rate of water from the tank.

(10 marks)

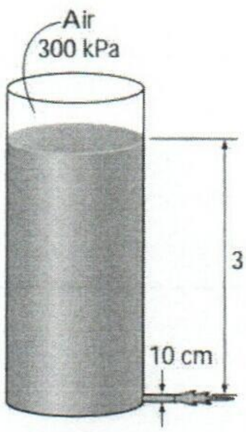

Figure Q2

Question 3

(a) Describe the Hydraulic Gradient Line and Total Energy Line.

(5 marks)

(b) A 6 cm diameter horizontal water pipe expands gradually to a 9 cm diameter pipe as shown in Figure Q3. The walls of the expansion section have an internal angle of 60° from the horizontal. The average velocity and pressure of water before the expansion section are 7 m/s and 150 kPa, respectively. Determine the following by referring Table Q3 given on page 5. (Assume $\alpha_1 = \alpha_2 = 1$).

I. Head loss in the expansion section

II. Pressure in the larger diameter pipe

(10 marks)

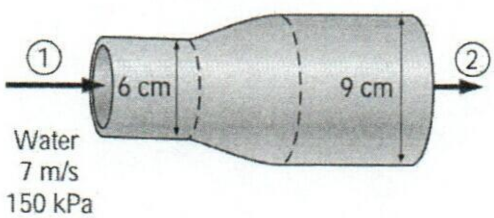

Figure Q3

Question 4

(a) Explain how the velocity of flow at any point in a pipe or a channel can be measured, with a pitot tube.

(5 marks)

(b) The reducing elbow in Figure Q4, is used to deflect water flow at a rate of 30 kg/s in a horizontal pipe upward by an angle of 45° from the flow direction while accelerating it. The elbow discharges water into the atmosphere. The cross-sectional area of the elbow is 150 cm^2 at the inlet and 25 cm^2 at the exit. The elevation difference between the centers of the exit and the inlet is 40 cm. The mass of the elbow and the water in it is 50 kg. Determine the anchoring force needed to hold the elbow in place.

(15 marks)

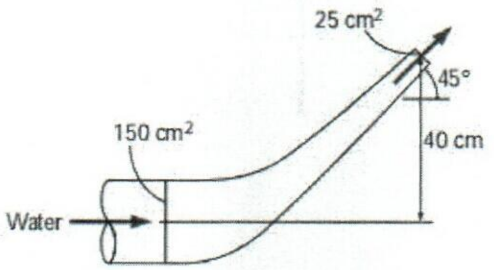

Figure Q4

Question 5

(a) "The casing area of a centrifugal pump gradually increases along the flow direction". Briefly describe the importance of the above statement.

(5 marks)

(b) Determine the flow rate in the pipe network given in Figure Q5 to the neatest L/sec **after two iterations**. Use the Hazen-Williams formula to determine head losses due to friction with C = 100 for all pipes and show your calculations using a tabular format.

(15 marks)

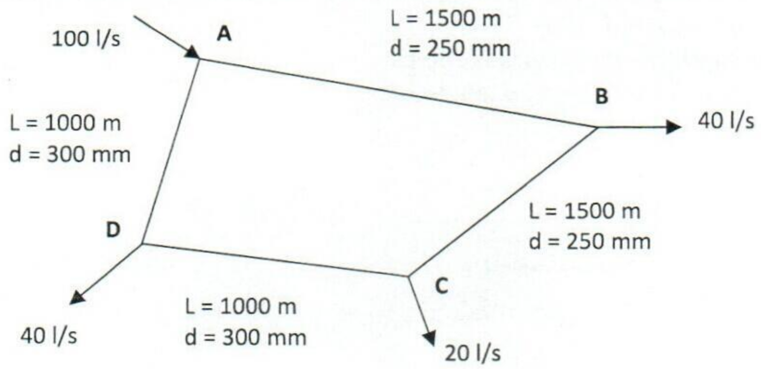

Figure Q5

Additional Information

Resultant Force Acting on a Submerged Surface

$$R = \rho g A\bar{y}$$

Vertical Distance

$$D = sin^2\phi\left(\frac{I_{GG} + A\left(\frac{\bar{y}}{sin\phi}\right)^2}{A\,\bar{y}}\right)$$

Bernoulli's Equation

$$Z_1 + \frac{P_1}{\rho g} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\rho g} + \frac{V_2^2}{2g}$$

Momentum Principle

$$\text{Resultant Force} = \rho\, Q\, (V_2 - V_1)$$

Hardy Cross Method

$$\Delta q = \frac{-\Sigma hf}{2\Sigma(\frac{hf}{Q})}$$

Hazen-Williams Formula

$$hf = \frac{6.784 * L}{d^{4.865}}\left(\frac{4}{C * \pi}\right)^{1.85} Q^{1.85}$$

Darcy's Formula

$$hf = \frac{4.\,f.\,L.\,v^2}{D.\,2g} \text{ or } hf = \frac{\lambda.\,L.\,v^2}{D.\,2g}$$

Minor Losses Equation

$$h_L = k\frac{v_1^2}{2g}$$

Non-Uniform Flow in Open Channels Equations

$$\text{Specific Energy (E)} = \frac{V^2}{2g} + y$$

$$yc = \sqrt[3]{\frac{Q^2}{B^2 g}}$$

$$Vc = \sqrt{yc.\,g}$$

Table Q3

θ	K_L
20	0.02
45	0.04
60	0.07

Faculty of Engineering & Technology

Department of Civil Engineering

Bachelor of Science Honours in Engineering in Civil Engineering

Final Examination 2024

Module Code	:	**CE4313**
Module Title	:	**Geotechnical Engineering**
Date	:	**08th May 2025**
Examiners	:	**Ms. Iromi Diyes**
Time Allowed	:	**3 hrs**

Instructions to Candidates:

- This paper consists of four (04) questions. Answer **all four** questions.
- All questions carry equal marks.
- This is an **OPEN BOOK Exam**
- 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.
- This examination accounts for 70% of the module assessment. The marks assigned for each question & sections thereof are indicated in square brackets.
- If you have any doubt as to the interpretation of the wording of a question, make your own decision, but clearly state it on the script.
- All Examinations are conducted under the rules & regulations of the Institution.

1 (a) Explain the modes of bearing capacity failures of foundations 20%

(b) A 5m square shallow foundation for a corner column of a residential building is subjected to vertical and lateral forces as shown in Figures Q.1.1 and Q.1.2. A single borehole drilled at the centre of the building indicated that the subsurface consists of a 4m thick clayey fill overlying a deep deposit of sandy clay as shown in Figure Q.1.1. The density and the strength of the soil layers were estimated from the SPT blow counts observed in the borehole and the same are given in Figure Q.1.2. It was reported that the water table within this area fluctuates from 2m depth to the ground surface level during dry and wet seasons respectively. Considering the fact that only one borehole is done at the site, estimate the ultimate carrying capacity of the footing assuming homogeneous subsurface conditions at the location of the footing using:

i. The method proposed by Meyerhoff. 40%

ii. Determine the factor of safety of the footing against shear failure. 20%

(c) Explain the reasons for the differential settlement between parts of a structure : 20%

2 (a) Describe the limitations of Terzaghi's Bearing Capacity equations and explain the motivations behind the development of more advanced bearing capacity formulations. 10%

(b) A 1500 mm diameter, 20 m long bored pile is installed as a single pile through the subsurface shown in Figure Q.2.1. The groundwater table is present at 2 m below the ground surface, and the unit weights and strength properties of the different soil layers are also given in the same figure. Determine the net ultimate bearing capacity of the pile. (Consider $c_a = c_u$) 50%

(c) Describe, with the use of a suitable sketch, the settlement effect that may occur with groups of piles within cohesive soil. 15%

(d) State the two common field tests that can be used to estimate pile capacities. 5%

(e) Both Terzaghi's and Meyerhof's equations assume that soil conditions are homogeneous. Describe how bearing capacities can be determined when there are non-homogeneous soil conditions present 20%

3 (a) Explain the concept of Limit State Design (LSD) as applied to geotechnical engineering according to Eurocode 7. What are the key limit states considered in the design of geotechnical structures, and how are they addressed? 15%

(b) An anchored sheet pile wall retains soil of height 8m. Figure Q 3.1. The piles having a total length of 12 m. the soil has a density of 18.5 kN/m^3 and an angle of friction 30 ^{0}. The surface of the retained side is level with the top of the wall. Anchor rods are at 1.5 m from the surface and are spaced at 3 m apart horizontally. Neglecting the friction of the surface of the piling and using the free earth support method, determine:

i) Factor of safety against mobilization of possible resistance 50%

ii) Pull of the anchor ties. 20%

(c) Explain briefly the difference between the 'free earth support' and 'fixed earth support' method of analysing the stability of anchored sheet piling. 15%

4 (a) Describe the stages and methods involved in a site investigation for a civil engineering project. Explain the significance of each stage and the various techniques used to gather data. *15%*

(b) Briefly Explain at least 3 methods of accelerating consolidation in the field. *15%*

(c) List the important information contained in a borehole log and explain how they are used? 20%

(d) A borehole investigation consisting of drilling three boreholes was carried out across the site up to the highly weathered rock. The subsurface condition and the SPT blow counts within the depth obtained from the borehole investigation are given in Figure Q 4.1.

i. Estimate the soil strength parameters corresponding to the SPT values at each depth required to estimate the ultimate carrying capacity of a footing. (Assume 55% energy efficiency of the hammer assembly, noliner, and 70mm diameter borehole) 50%

-End of Question-

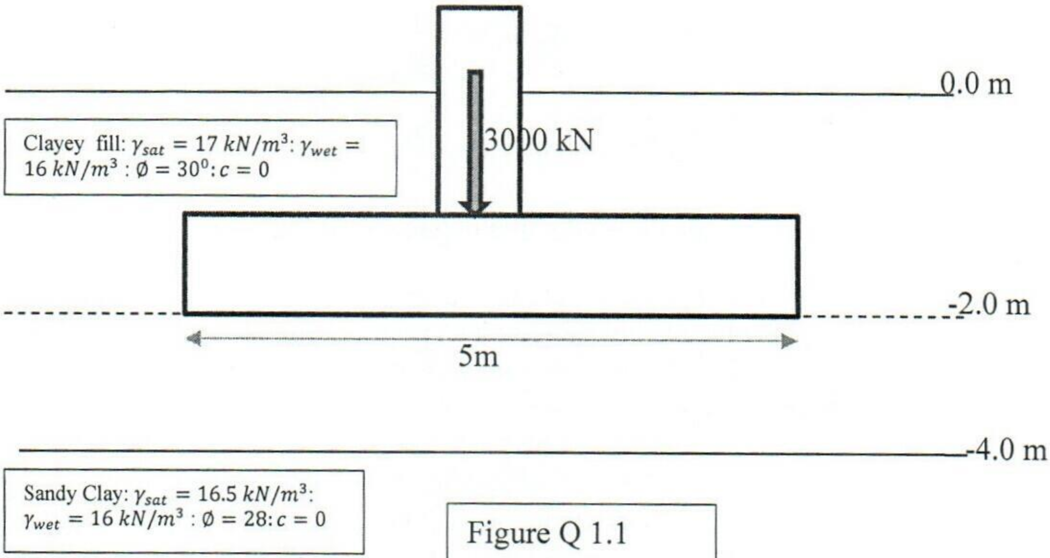

Figure Q 1.1

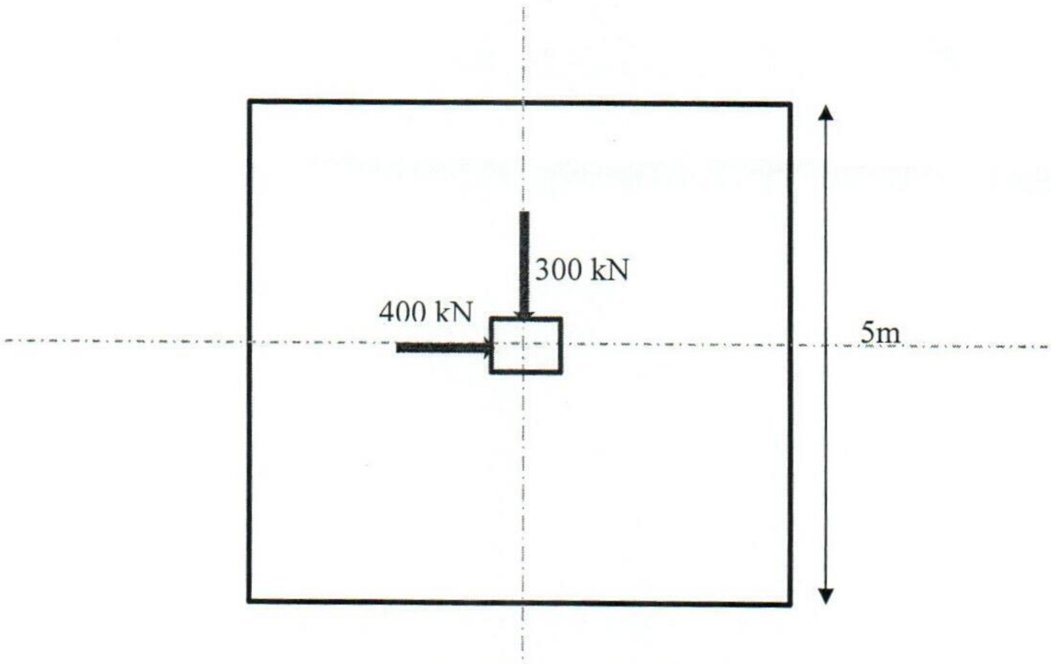

Figure Q 1.2

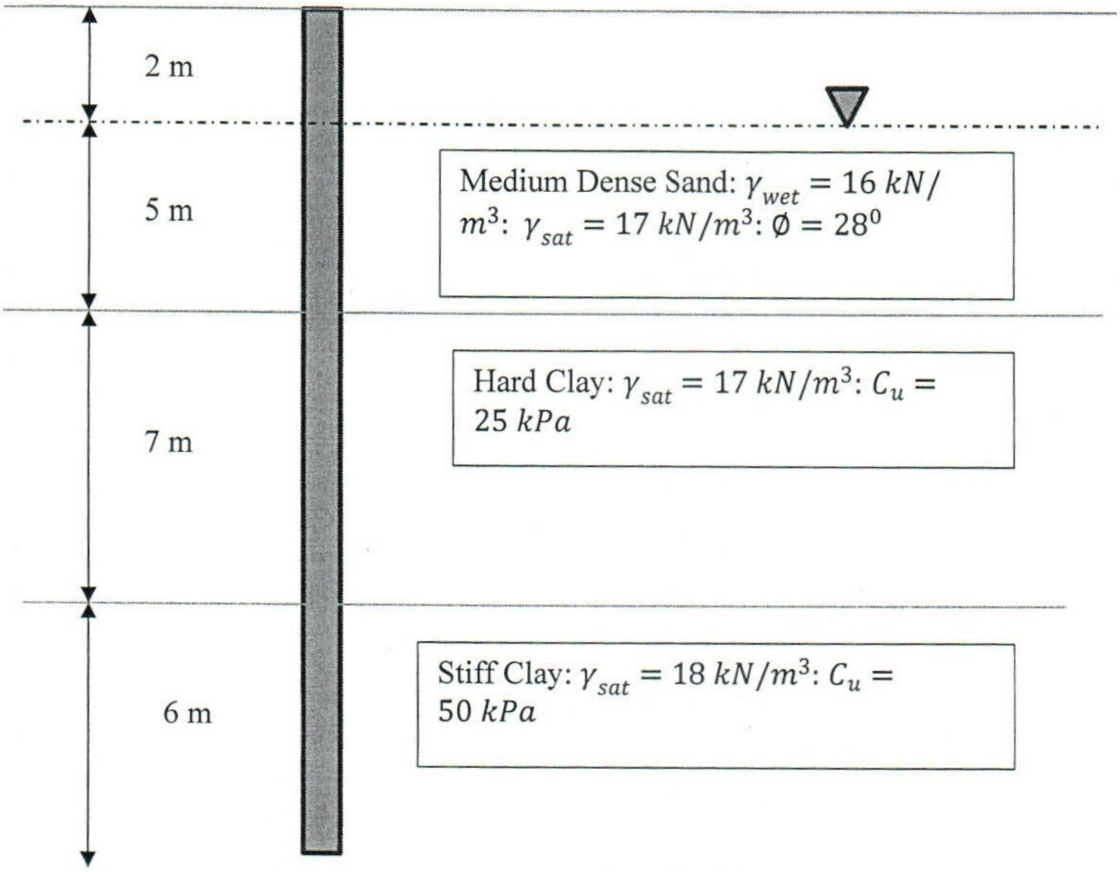

Figure Q 2.1

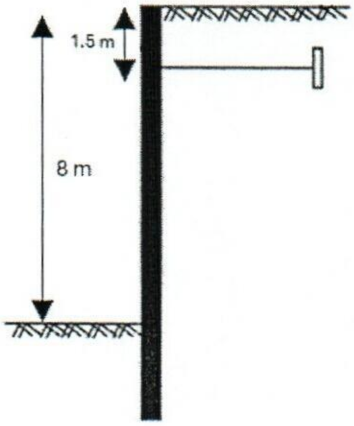

Figure Q 3.1

	Depth m	SPT
0.0 m		
0.75 m	1.0 -1.45 m	- 7
Fine Sandy Lateritic Fill: $\gamma_{wet} = 16.5\ kN/m^3$:	2.0 -2.45 m	- 9
2.70 m ▽	3.0 -3.45 m	- 7
	4.0 -4.45 m	- 8
NC Silty Clay: $\gamma_{sat} = 16\ kN/m^3$:	5.0 -5.45 m	- 8
	6.0 -6.45 m	- 9
7.50 m	7.0 -7.45 m	- 8
	8.0 -8.45 m	- 22
	9.0 -9.45 m	- 20
Medium Sand: $\gamma_{sat} = 17\ kN/m^3$:	10.0 -10.45 m	- 27
	11.0 -11.45 m	- 32
	12.0 -12.45 m	- 34
	13.0 -13.45 m	- 32
14.80 m	14.0 -14.45 m	- 37
Highly Weathered Rock		

Figure Q4.1

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Faculty of Engineering & Technology

BSc (Hons) in Engineering in Civil Engineering

CE4414 Structural Design III

Module Leader: Dr. Pasindu Weerasinghe

Academic Year 2025

Total time allocated 3 hours

INSTRUCTIONS TO CANDIDATES

This paper contains 2 questions on 7 pages.

Answer all the questions

This is an open book and open notes examination. Candidates are permitted to refer hard copies of Eurocode, National Annexes, lecture notes, and any other handwritten notes during the examination.

The total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in each question.

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the answer script.

Assume reasonable values for any data not given in or provided with the question paper, clearly state such assumptions made in the answer script.

You may use sketches in providing answers for the descriptive questions.

Question 01 **(50 Marks)**

A two-storey residential house is proposed to be constructed with load bearing masonry walls. Figure Q1.A and Q1.B shows the plan views of the ground floor and first floor as per the architectural drawings. Load bearing masonry walls are highlighted. Both first floor and roof are of reinforced concrete slabs having a thickness of ***t***. First floor has a void just above the living and dining area while the roof slab covers the whole house.

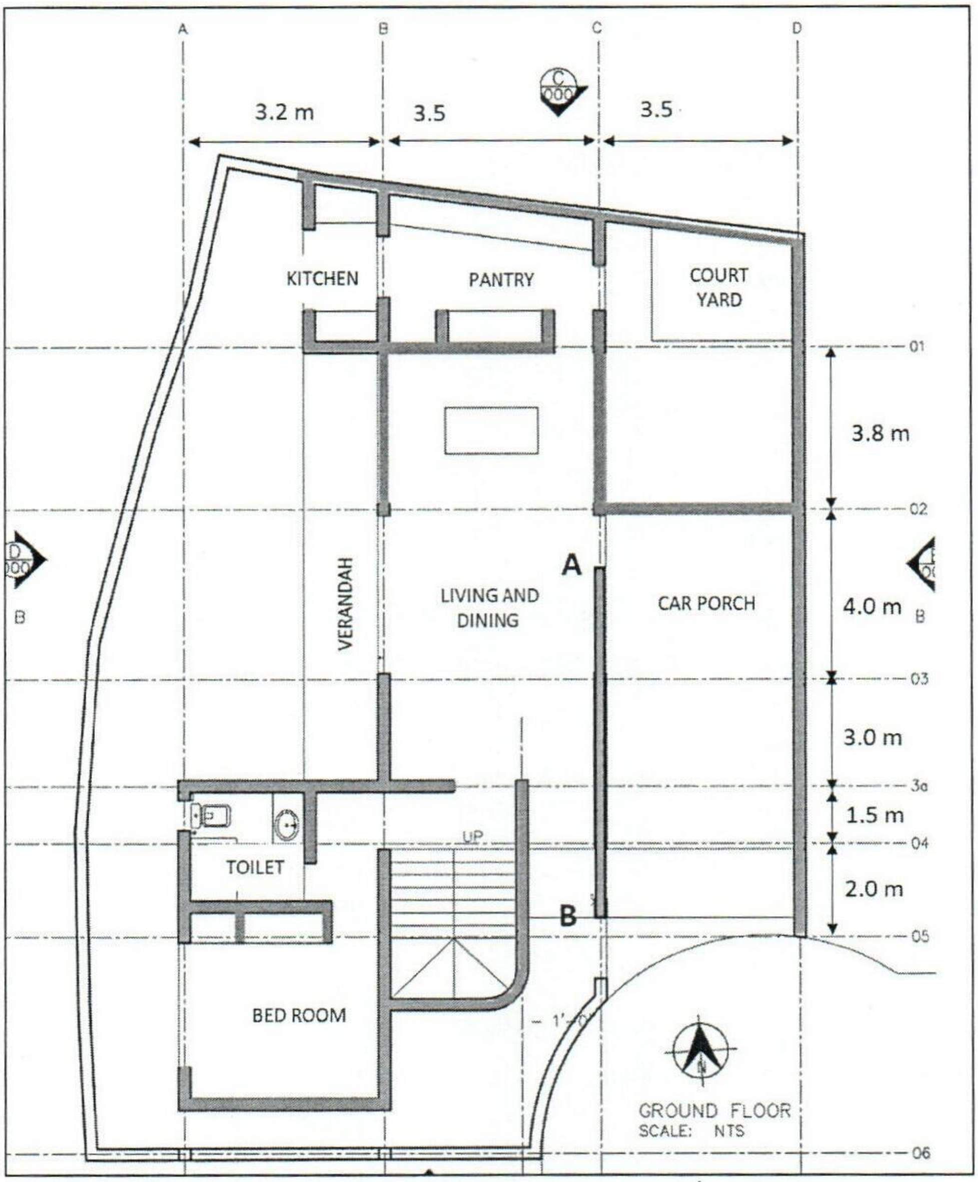

Figure Q1.A Ground floor plan view

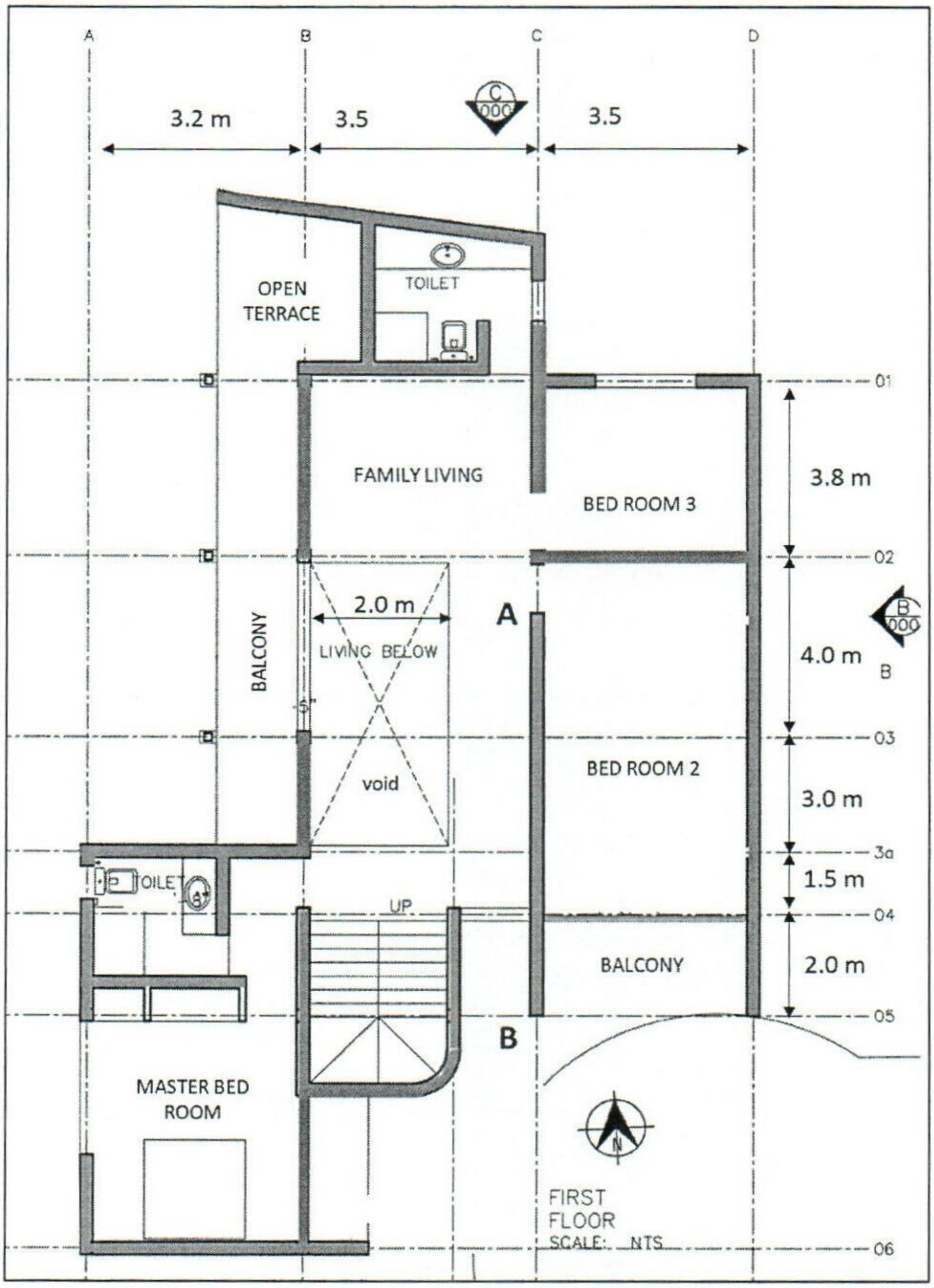

Figure Q1.B First floor plan view

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Wall thickness (without plaster)	275 mm
Slab thickness (t)	175 mm
Floor to floor height	4.0 m

* Walls have 10 mm plaster on either side

Following data is given.

- The density of reinforced concrete - 25 kN/m^3
- The allowance for finishes of the slab -1.0 kN/m^2
- The live load acting on the slab :
  - Bedroom, balcony and roof - 1.5 kN/m^2
  - Living - 2.0 kN/m^2
- The self-weight of masonry with standard format bricks = 22 kN/m^3
- The density of cement plaster = 22 kN/m^3
- Elastic modulus of concrete = 31,000 N/mm^2
- Elastic modulus of masonry = 1,500 N/mm^2

You may assume any other parameters that are not given, but clearly state your assumptions. You are expected to carry out the design according to Eurocode 6.

a) You need to design **wall AB** at the ground floor level. Find the slenderness ratio and check against the limiting value. *[03 marks]*

b) Determine the vertical design loads per unit length acting at the first floor level, mid height of ground floor wall and bottom of ground floor wall due to the first floor and roof loads. *[08 marks]*

c) Total out-of-balance moment transferred to the wall AB at the first floor level was found to be 1.5 kNm/m. Determine the moments at mid-height and bottom of the wall. *[06 marks]*

d) Determine the total eccentricity that can be considered at the top, mid height, and bottom of the wall. *[06 marks]*

e) Determine the slenderness reduction factors at top, mid height, and bottom of the wall. Hence, find the characteristic masonry strength required at those locations. *[08 marks]*

f) Based on your findings calculate the strength of bricks required, assuming mortar designation M4 is to be used during construction. *[05 marks]*

g) The client wants to construct a free-standing boundary wall for the proposed house using standard bricks of 5 MPa strength and mortar designation M4. The height, thickness and the calculated lateral wind pressure acting on the wall are shown in Table below. Determine the adequacy of the wall thickness, assuming the wall behaves as a cracked section.

[10 marks]

Wall height	1.5 m
Wall thickness	105 mm
Wind pressure	0.80 kN/m^2

h) Once the house has constructed, the client has noticed some cracks in walls as shown in the Figure Q1.C. How would you explain this type of cracking and what could have been done to prevent such cracking? *[04 marks]*

Figure Q1.C Cracking of walls

Question 02 **(50 marks)**

You are assigned as a member of the structural design engineering team for a new building complex for a university. It is proposed to construct an elevated timber deck for the canteen. It consists of 25 mm thick 250 mm wide timber floor planks that will be supported on timber beams. The timber beams will rest on wall plates that will be supported on short masonry walls. Figure Q2.a shows a timber floor beam that supports the floor boards. The distance between the supports is 5.0 m and the overhang is 1.0 m. The beams are to be spaced at a distance of 1.5 m. The proposed dimensions of the timber beam are 100 mm x 200 mm and it is intended to use D50 timber.

The floor beam has been analyzed and the results are given below.

At Ultimate Limit State

- Design bending stress in the timber beam - 15 N/mm^2
- Design shear stress in the timber beam – 1.0 N/mm^2
- Design bearing action in the beam at support B – 5 kN

At Serviceability Limit State

- Maximum instantaneous deflection in the floor beam – 10 mm

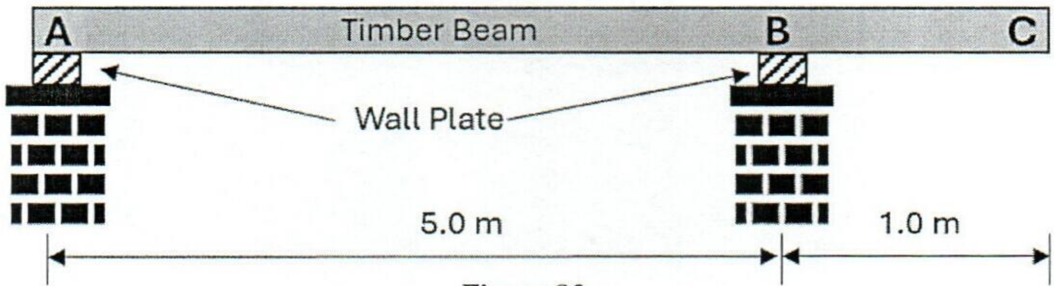

Figure Q2.a

a. Check whether the proposed dimensions of the timber floor boards (planks) are suitable considering the limit state of deflection, if the instantaneous deflection of timber plank is 1.8 mm under serviceability conditions. *[5 marks]*

b. Check whether the floor beam is safe in bending under long term service class 3 conditions. *[6 marks]*

c. Briefly explain whether there is a danger of lateral buckling and twisting of the floor beam and where this would occur, if it is assumed that the floor boards provide lateral support to the floor beam. No calculations are required. *[6 marks]*

d. Check whether the floor beam is safe in shear under long term service class 3 conditions. *[6 marks]*

e. Determine the minimum width required of the wall plate at support B considering the bearing failure. *[7 marks]*

A roof truss is made of D70 structural timber. Figure Q2.b shows a proposed detail of a connection at the roof truss. Two 12 mm diameter bolts, with a yield strength of 600 N/mm^2, are to be used. The side members are 30 mm thick, and the middle member is 60 mm x 100 mm.

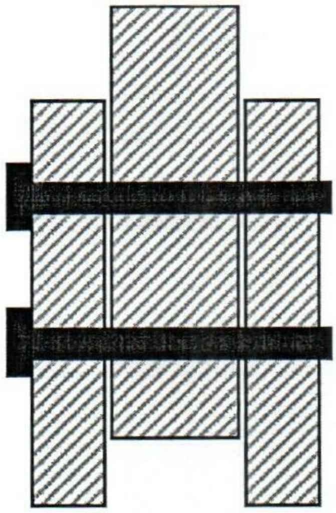

Figure Q2.b

f. Determine the type of connection. *[02 marks]*

g. Find the characteristic embedment strength ($f_{h,k}$) of timber. *[04 marks]*

h. Calculate the characteristic yield moment ($M_{y,Rk}$) of the bolt. *[04 marks]*

i. Hence, calculate the capacity of the connection and the failure mode, neglecting the rope effect ($F_{ax,Rk} = 0$) *[10 marks]*

End of question paper