Faculty of Engineering & Technology

Bachelor of Science Honours in Engineering in Civil Engineering

CINEC CAMPUS
Beyond A Graduate

CE4313 Geotechnical Engineering

Final Examination

Module Leader: Ms. Iromi Diyes

Academic Year: 2026

Date: 10th April 2026

Duration: 03 hours

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) Describe the different modes of failure that may occur in foundations. Illustrate your answer with clearly labelled sketches. *20%*

(b) It is proposed to construct a square pad footing of 3.5 m × 3.5 m at a depth of 1.2 m below the ground surface to support a column. The subsoil consists of uniform medium dense sand extending to a considerable depth. The soil strength parameters are estimated as:

- Effective cohesion, $c' = 0$ kN/m²
- Angle of internal friction, $\varphi' = 32°$
- Bulk unit weight of soil, $\gamma = 17$ kN/m³
- Saturated unit weight of the soil is $\gamma_{sat} = 19\ kN/m^3$

The footing is subjected to a vertical load of 1200 kN acting at the centre of the column. In addition, due to structural loading conditions, the footing is subjected to:

- A moment of 240 kNm acting parallel to the length of the footing, and
- A moment of 180 kNm acting parallel to the width of the footing

The groundwater table is located at a depth of 2.5 m below the ground surface.

60%

i. Calculate the ultimate bearing capacity of the footing using Meyerhoff method.

20%

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

2 (a) Briefly explain the factors that must be considered when selecting the appropriate type of foundation for a structure. Illustrate your answer with clearly labeled sketches where necessary. *10%*

(b) A 1.2 m diameter bored 18m long, cast-in-situ concrete pile is to be constructed in a soil profile as shown in Figure 2. The soil layer properties are also provided in the figure. *50%*
Determine the ultimate load carrying capacity of the pile. If any required data are missing, make reasonable engineering assumptions and clearly state them in your calculations.

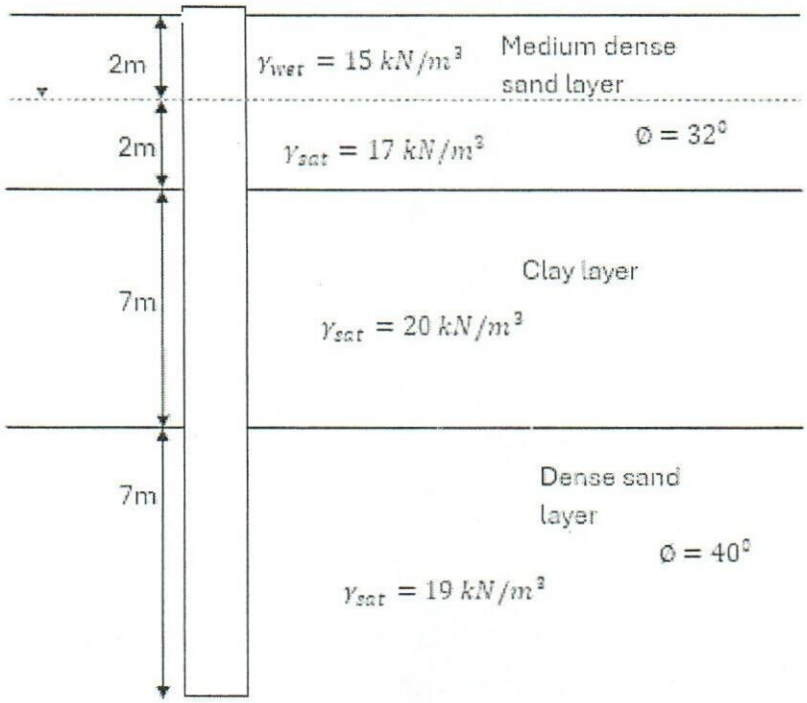

Figure 2

(c) Emphasise the reasons for the differential settlement between parts of a structure. *10%*

(d) Explain 3 methods of accelerating consolidation in the field. *10%*

(e) Briefly explain the factors affecting the consolidation. *20%*

3 *(a)* 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. *15%*

(b) A cantilever sheet pile retaining wall is to be constructed to retain a 5 m high vertical excavation in sandy soil. The wall is embedded below the dredge level to provide stability without the use of anchors, as shown in Figure Q4.
The groundwater table is located at the ground surface on both sides of the wall.
Determine:

The required depth of embedment of the sheet pile wall:
You may assume the following soil properties:
(i) Angle of internal friction, $\phi' = 32°$
(ii) Unit weight of soil, $\gamma = 18\ kN/m^3$
(iii) Factor of safety against passive resistance = 1.5
(iv) Use Rankine earth pressure theory *70%*

Clearly show all calculations and state any assumptions made.

(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 the factors need to be considered when selecting the type of the pile foundation, to be constructed. 20%

(c) Briefly explain the methods available to estimate the geotechnical capacity of a pile and clearly give the steps that involve in a pile driving criteria. 15%

(c) 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.

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 65% energy efficiency of the hammer assembly, noliner, and 70mm diameter borehole) 50%

-End of Question-

0.0 m

1.0m

Fine Sandy Lateritic Fill: $\gamma_{wet} = 16.5\ kN/m^3$:

2.5 m

NC Silty Clay: $\gamma_{sat} = 16\ kN/m^3$:

7.50 m

Medium Sand: $\gamma_{sat} = 17\ kN/m^3$:

14.50 m

Highly Weathered Rock

Depth m	SPT
1.0 -1.45 m	- 6
2.0 -2.45 m	- 5
3.0 -3.45 m	- 7
4.0 -4.45 m	- 9
5.0 -5.45 m	- 9
6.0 -6.45 m	- 8
7.0 -7.45 m	- 10
8.0 -8.45 m	- 25
9.0 -9.45 m	- 24
10.0 -10.45 m	- 27
11.0 -11.45 m	- 32
12.0 -12.45 m	- 34
13.0 -13.45 m	- 32
14.0 -14.45 m	- 37

Figure Q4