DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATIONS FOR:

THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING

(Y3S1/Y2S1)

ECV 4315/TCV 4212: SOIL MECHANICS I

END OF SEMESTER EXAMINATIONS

SERIES: JANUARY 2025

TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE:

1. You should have the following for this examination:
   - **Answer booklet.**
   - **Mathematical Table/Pocket Calculator.**
2. This paper consists of **FOUR** questions.
3. Answer question **ONE (Compulsory)** and any other **TWO** questions.
4. This paper consists of **FIVE** printed pages.
5. **Do not write on the question paper.**

Question ONE (compulsory): Soil formation & Soil physics

(a) Using diagrams, illustrate the following forms of soil structure:
   (i) Single grain structure,
   (ii) Disperse soil structure,
   (iii) Flocculent soil structure.

(9 marks)

(b) A soil sample in its natural state has a mass of 2.290 kg and a volume of 1.15×10^{-3} m^3. In an oven dried state, the dry mass of the sample is 2.035 kg and the specific gravity G_s of the solids is 2.68.
Determine:
   (i) The bulk density,
   (ii) The bulk unit weight,

(iii) Water content,
(iv) The dry unit weight,
(v) Void ratio,
(vi) Saturated unit weight,
(vii) Sub-merged unit weight,
(viii) Porosity,
(ix) Degree of saturation,
(x) Air voids ratio.

(21 marks)

Question TWO: Soil classification

The results of a sieve analysis, on a soil sample are presented in Table 2.1.

Table 2.1: Sieve analysis results

Sieve size (mm)	Mass retained (g)
37.50	0.0
20.00	26.0
10.00	31.0
5.00	11.0
2.00	18.0
1.18	24.0
0.600	21.0
0.300	41.0
0.212	32.0
0.150	16.0
0.063	15.0
Mass passing 0.063	15.0

For the soil tested:

(a) Plot the standard grading curve,
(b) Determine:
    (i) the effective size,
    (ii) Uniformity coefficient,

(iii)Coefficient of curvature.

(20 marks)

Question THREE: Soil Compaction

The results of a compaction test are set out below
Table 3.1

Moisture content (%)	12.8	14.5	15.6	16.8	19.2
Mass of wet soil (g)	2010	2092	2114	2100	2055

Specific gravity of solids $G_s = 2.67$ and volume of the mould was 1.000 m^3.

(a) (i) Plot the curve of dry density against moisture content and determine the values of maximum dry density and optimum moisture content,

(ii)On your graph, plot the 0.0% and 5% air voids lines,

(b) Calculate the air voids percentage at maximum dry density.

Hint:

Moisture content		%	12.8	14.5	15.6	16.8	19.2
		Decimal (w)					
Mass of the wet soil (g)			2010	2092	211 4	2100	2055
Bulk density $\rho_b = \frac{mass\,of\,soil}{vol.\,of\,mould}$ (kg/m^3)							
Dry density (kg/m^3)	$\rho_d = \frac{\rho_b}{1+w}$						
	$\rho_d = \frac{G_s(1-A_r)}{1+w\,G_s}\rho_w$	For saturation line, $A_r = 0$					
		For 5% air voids, $A_r = 0.05$					

(20 marks)

Question FOUR: Principle of effective stress

Figure 4.1 shows a layout of soil strata.

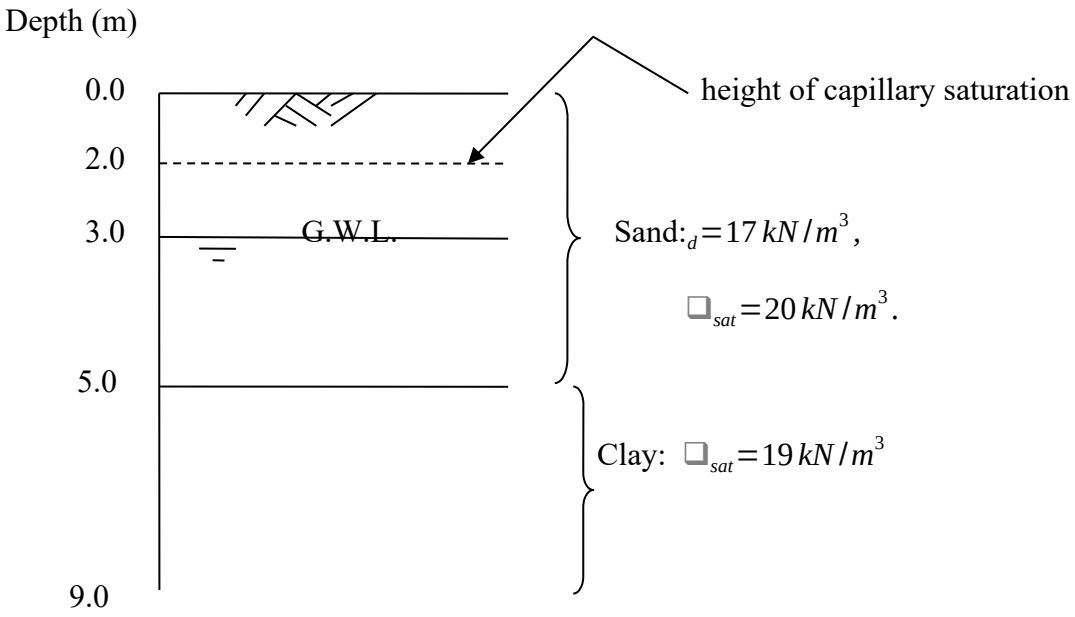

Figure 4.1: Details of a borehole log

Draw graphs showing the variation with depth, of total vertical stress, pore pressure and effective vertical stress.

(20 marks)