First Semester Examination
2021/2022 Academic Session

February/March 2022

EAG245 – Soil Mechanics

Duration : 2 hours

Please check that this examination paper consists of **TWELVE (12)** pages of printed material including appendix before you begin the examination.

Instructions : This paper contains **FOUR (4)** questions. Answer **ALL** questions.

All questions **MUST BE** answered on a new page.

1. (a). A raft foundation for a new housing project at Taman Ilmu, Nibong Tebal, will be built on fine-grained soil with a liquid limit of 160% and a plastic limit of 53%. The natural water content of the fine-grained field is 85%, and the clay content is 75% with montmorillonite mineralogy. Based on the characteristics of the clay mineral and the Atterberg Limits given, examine the condition of the raft foundation founded on the fine-grained soil with time.

[5 marks]

(b). Weight-volume relationships include void ratio, porosity, degree of saturation, moisture content, and weight parameters. Derive the relationship between bulk and dry unit weights. Based on the derivation, determine the dry unit weight of a soil sample weighing 1930 grams, with volume of 900 cm^3, and water content of 15.6%.

[8 marks]

(c). A fall cone test on the marine clay obtained at the new factory site at Batu Kawan is given in **Table 1**.

Table 1

Liquid Limit (Fall Cone Test)				
Penetration	11.5	18.1	22.6	26.5
Container No.	1	2	3	4
Mass of wet soil + container (g)	19.90	22.60	25.40	33.30
Mass of dry soil + container (g)	18.60	20.60	22.70	28.30
Mass of container (g)	10.90	10.00	9.10	4.40

i) Determine the moisture content for all soil samples.

[5 marks]

ii) Plot the results of the Fall Cone test and determine the liquid limit of the soil.

[4 marks]

iii) If the plastic limit of the soil is 11.7, determine the plasticity index of the soil.

[3 marks]

2. (a). A soil sample was taken during the earthwork for new housing development in Ipoh, Perak, and used to classify the soil further. The result of one of the sieve analysis tests is given in **Table 2**.

Table 2

Sieve Size (mm)	Weight Retained (g)
14.00	0.00
10.00	0.00
6.30	0.00
5.00	0.12
3.35	0.19
2.00	1.15
1.18	7.17
0.600	31.89
0.425	4.08
0.300	2.10
0.212	1.61
0.150	0.38
0.063	0.50
Pan	0.81
	50.00

i) Plot the grain size distribution curve for the soil sample

[8 marks]

ii) Calculate the Uniformity Coefficient (C_u) and Coefficient of Curvature (C_c) of the soil.

[4 marks]

iii) Based on the result obtained in (ii), describe the drainage condition of the soil.

[4 marks]

iv) Classify the soil using the Unified Soil Classification System (USCS) (Refer to **APPENDIX 1**).

[4 marks]

(b). The position and shape of the grading curve determine the soil class.

i) Describe the possible soil types (A, B and C) based on the grain size distribution curves given in **Figure 1**.

[3 marks]

ii) Select the most problematic soil based on the GSD curves shown in **Figure 1**.

[2 marks]

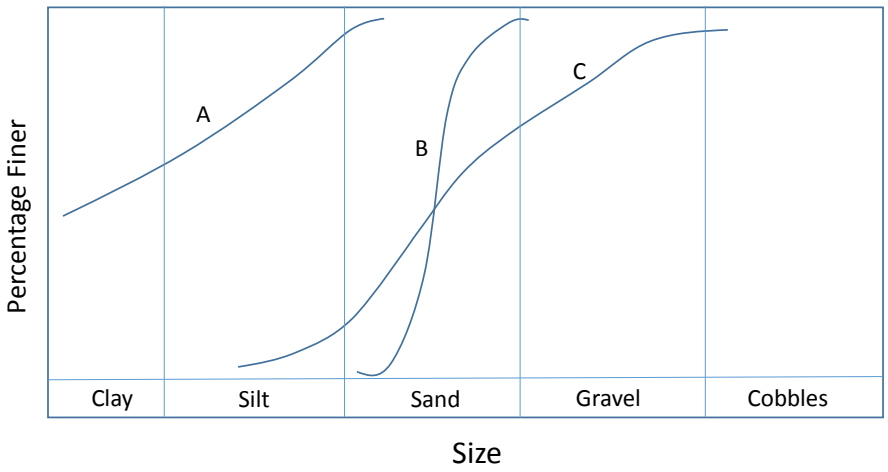


Figure 1

…6/-

3. Compaction work is carried out on a 15 hectare site in preparation for the construction of a quarantine centre. The results of the standard compaction test on a sample taken from the site prior to earthwork are shown in **Table 3**. The current stage of construction has reached the final platform level. Based on the latest density test conducted on-site, the soil's dry density is 1.72 g/cm^3.

Table 3

Bulk Unit Weight (kN/m^3)	16.0	18.8	19.0	18.5	18.0
Water Content (%)	4.0	6.0	8.0	10.0	12.0

(a). Determine the optimum moisture content of the soil that will be used as fill material.

[9 marks]

(b). Determine whether the current level of compaction is sufficient based on the results from **Table 3**, if the specification requires that the soil is compacted to at least 95% standard compaction.

[6 marks]

(c). Describe the next step the contractor should take based on the current level of compaction of the earthwork.

[3 marks]

(d). A 3.0 metre embankment is being constructed at this site. With the help of sketch, explain **ONE (1)** of the consequences of improper soil compaction on a construction project.

[7 marks]

4. (a). A phase diagram and other basic theory of the consolidation define the relationship between the consolidation settlement with the other basic parameters.

With the aid of sketches and diagrams explain **ONE (1)** of the methods used to evaluate **TWO (2)** most important consolidation parameters below. State the importance and the use of each parameter to solve any consolidation problems.

i) Pre-Consolidation Pressure
ii) Compressibility Indexes

[8 marks]

(b). The following results were obtained from a set of consolidation test on a specimen of a clay sample taken from a 4.5 m thick clay layer on one construction site which are overlaid and underlaid by a thick layer of coarse sand.

Pressure kN/m^2	**Void Ratio After The Test**
200	0.98
400	0.76

Estimate the total consolidation settlement of the clay layer based on the variation of the pressure as above.

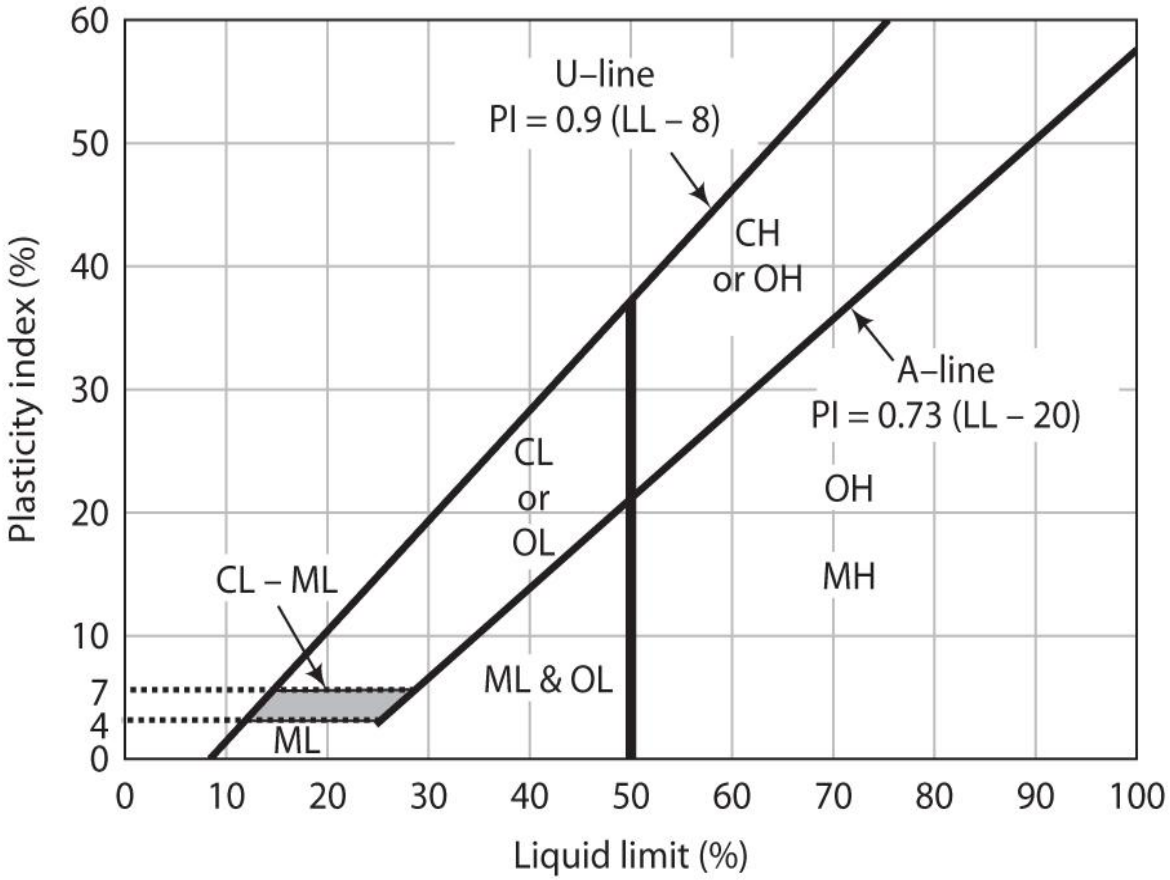
[7 marks]

(c). During the construction of a highway bridge, it is expected that the average permanent load on a clay layer will increase by about 100kPa. The average effective overburden pressure at the middle of the clay is 120kPa. The thickness of the clay is 6m, and the value of C_v is equal to 0.38 m^2/month, and the clay is normally consolidated. Determine the surcharge required to eliminate the entire primary consolidation in 6 months. Use **Appendix 2** to solve the problem and state any assumption made.

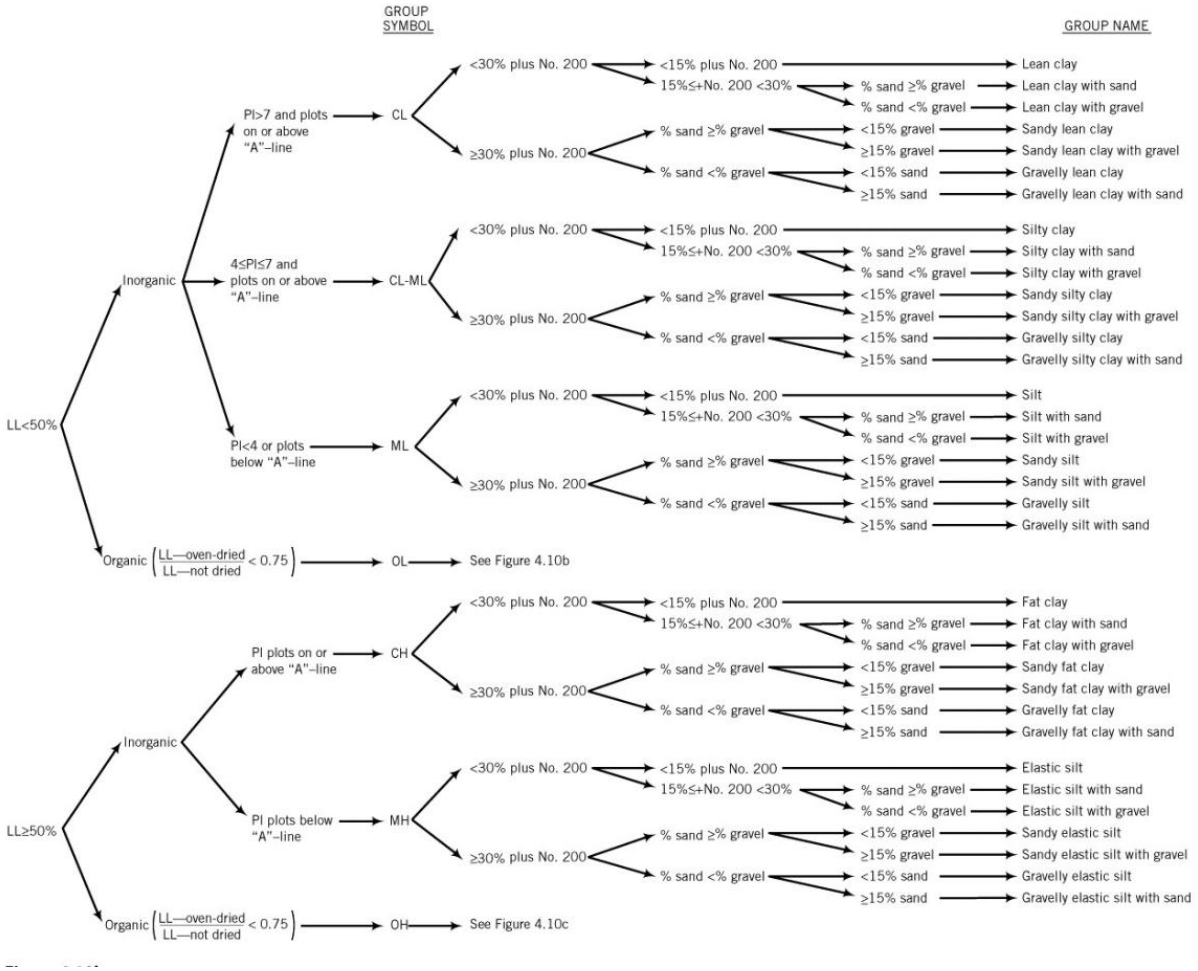
[10 marks]

APPENDIX:

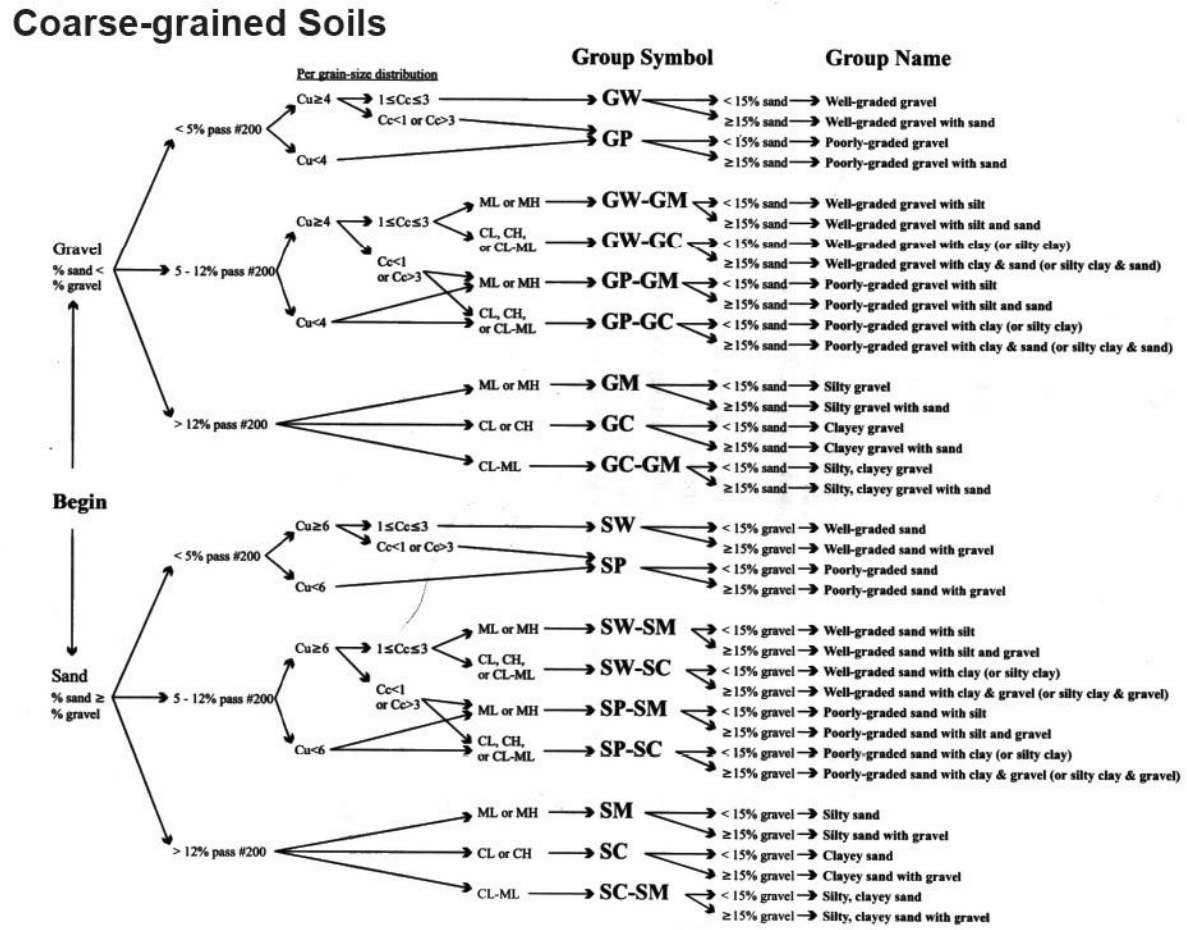
APPENDIX 1



APPENDIX 1


GROUP SYMBOL
GROUP NAME
LL<50%
Inorganic
PI>7 and plots on or above "A"–line
CL
<30% plus No. 200
<15% plus No. 200
Lean clay
15%≤+No. 200 <30%
% sand ≥% gravel
Lean clay with sand
% sand <% gravel
Lean clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy lean clay
≥15% gravel
Sandy lean clay with gravel
% sand <% gravel
<15% sand
Gravelly lean clay
≥15% sand
Gravelly lean clay with sand
4≤PI≤7 and plots on or above "A"–line
CL-ML
<30% plus No. 200
<15% plus No. 200
Silty clay
15%≤+No. 200 <30%
% sand ≥% gravel
Silty clay with sand
% sand <% gravel
Silty clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy silty clay
≥15% gravel
Sandy silty clay with gravel
% sand <% gravel
<15% sand
Gravelly silty clay
≥15% sand
Gravelly silty clay with sand
PI<4 or plots below "A"–line
ML
<30% plus No. 200
<15% plus No. 200
Silt
15%≤+No. 200 <30%
% sand ≥% gravel
Silt with sand
% sand <% gravel
Silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy silt
≥15% gravel
Sandy silt with gravel
% sand <% gravel
<15% sand
Gravelly silt
≥15% sand
Gravelly silt with sand
Organic (LL—oven-dried / LL—not dried < 0.75)
OL
See Figure 4.10b
LL≥50%
Inorganic
PI plots on or above "A"–line
CH
<30% plus No. 200
<15% plus No. 200
Fat clay
15%≤+No. 200 <30%
% sand ≥% gravel
Fat clay with sand
% sand <% gravel
Fat clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy fat clay
≥15% gravel
Sandy fat clay with gravel
% sand <% gravel
<15% sand
Gravelly fat clay
≥15% sand
Gravelly fat clay with sand
PI plots below "A"–line
MH
<30% plus No. 200
<15% plus No. 200
Elastic silt
15%≤+No. 200 <30%
% sand ≥% gravel
Elastic silt with sand
% sand <% gravel
Elastic silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy elastic silt
≥15% gravel
Sandy elastic silt with gravel
% sand <% gravel
<15% sand
Gravelly elastic silt
≥15% sand
Gravelly elastic silt with sand
Organic (LL—oven-dried / LL—not dried < 0.75)
OH
See Figure 4.10c

APPENDIX 1



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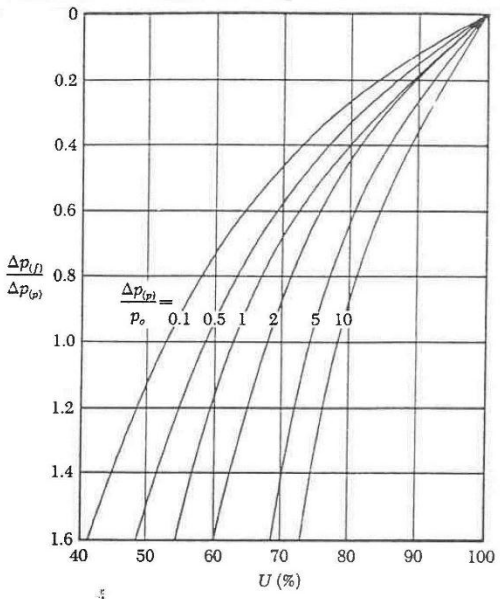
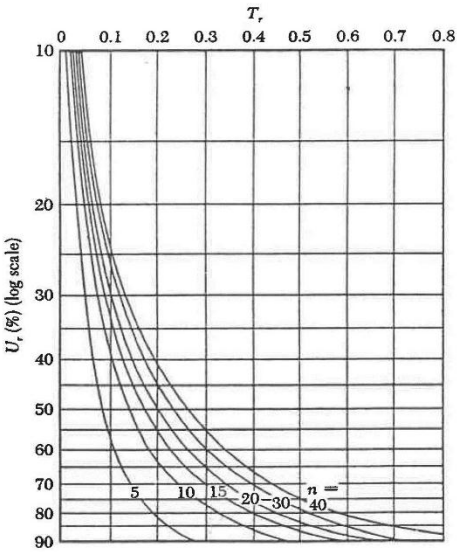
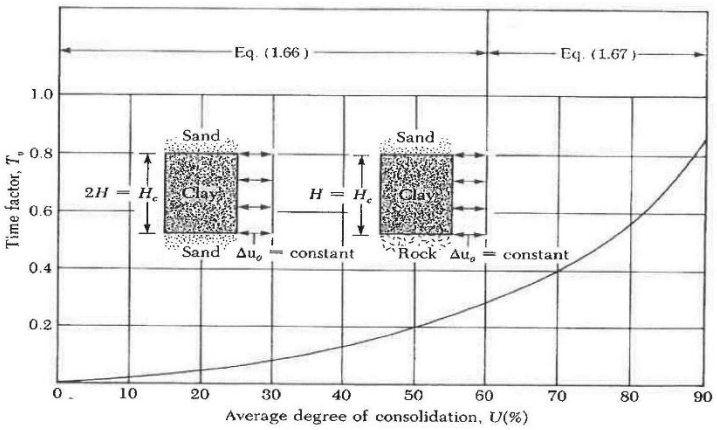
Appendix 2



Plot of $\Delta p_{(f)}/\Delta p_{(p)}$ against U for various values of $\Delta p_{(p)}/p_o$



Average degree of consolidation for radial drainage only



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