Module (Course Syllabus)

Catalogue 2022-2023

College	**Erbil Technical Engineering College**
Department	**Highway Engineering Department**
Module Name	**Soil Mechani s**
Module Code	**SOM603**
Degree	**Technical Diploma** ☐ **Bachelor** ■ **High Diploma** ☐ **Master** ☐ **Ph** ☐
Semester	**6th**
Qualification	
Scientific Title	**Assistant Lecturer**
Credit	**6**
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐
Module type	**Core**
Weekly hours	**6**
Weekly hours (Theory)	**(4)hr Class** — **(162) hrs Workload**
Weekly hours (Practical)	**(2)hr Class**
Number of Weeks	**12**
Lecturer (Theory)	**Bafreen Chalabi Zero**
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Mobile	**0**
Lecturer (Practical)	**Ahmed Suad ALi**
Email	**ahmed.ali@epu.edu.iq**
Mobile	

Course Book

Course Description	The Soil Mechanics have divided into two parts, theoretical and laboratory parts. Theoretical Surveying lectures will help students to learn and easily recognize of the Soil Mechanics such as weight- volume relationships how to learn about in most applications, the phases include solid particles, water and air. Water and air occupy voids between the solid particles. For Soil in particular, the physical relationship between the solid particles. Soil particle size, clay mineral, compaction, stresses in soil mass, shear stresses all of them related to density, optimum moisture content, maximum dry density, and remove soil according to work.
Course objectives	The Soil Mechanics lectures will help students to learn and easily recognize of the soil traits, which it is relate to all of the highway and civil engineering works as the following: -To perform the Engineering soil surveys. -To develop rational soil sampling devices and soil sampling methods. To develop suitable soil testing devices and soil testing methods. - -To collect and classify soils and their physical properties on the basis of fundamental knowledge of Soil Mechanics. -To investigate the physical properties of soil and determine the coefficients to characterize these properties. Ministry of Higher Education and Scientific research -To evaluate the soil test results and other applications as a construction material. -To understand various factors such as static and dynamic loads, water and temperature.
Student's obligation	The students should be a viable during lecture time table when the student absent more Then the allowed hours the student will be dismissed. Students should be doing quizzes, practical reports, seasonal tests and final exams in order to able to collect required mark to success. All students are required to fulfil the following requirements: ➢ Attendance ➢ Participation in problem solving and class activities ➢ Doing homework ➢ Participation in quiz ➢ Participation in exams ➢ Conducting projects ➢ Presenting seminars ➢ Preparing reports
Required Learning Materials	During lecturing the data show is used for showing lecture notes using power point program while the white board is used for explanation and solving problems and using soil instruments in laboratory but in highway department don't have this instruments. Using video for practical soil.

Evaluation	**Task**	**Weight (Marks)**	**Due Week**	**Relevant Learning Outcome**
	Paper Review		Depending on activity given	Each activity will give storm braining and additional knowledge to the subject
	Assignments: Homework	5%		
	Assignments: Class Activity	2%		
	Assignments: Report	10%		
	Assignments: Seminar			
	Assignments: Essay			
	Assignments: Project			
	Quiz	8%		
	Lab.	10%		
	Midterm Exam (Theory)	10%		
	Midterm Exam (Pract.)	15%		
	Final Exam(thr)	20%		
	Final Exam(pract.)	20%		
	Total	100%		

Specific learning outcome:

One basic and very important objective of study Soil Mechanics is: The Soil Mechanics lectures will help students to learn and easily recognize of the Soil Mechanics, which it is relate to all of the civil engineering and highway engineering.

Course References:

- Principle of Geotechnical Engineering and Solution manual by Braja M.Das Ed-2009
- Introduction Soil Mechanics by bela Bodo and Colin Jones
- Experimental Soil Mechanics by Jean-pierree Bardet
- Soil Mechanics in Engineering Practice by karl Terzaghi, Ralph B. Peck and Gholamr eza Mesri
- Basic and Applied Soil Mechanics by Gopal Ranjan
- Limit Analysis and Rheological Approach in Soil Mechanics (CISM International Centre for Mechanical Sciences, 217) (English and French Edition) 1978th Edition, French Edition, by W. Olszak (Editor), L. Suklje (Editor), G. de Josselin de Jong (Contributor), Z. Mroz (Contributor), C. Szymanski (Contributor)
- Soil Mechanics Laboratory Manual 9th Edition, by Braja Das.

Course topics (Theory)	Week	Learning Outcome
Introduction to Soil Mechanics	1	To perform the Engineering soil surveys. -To develop rational soil sampling devices and soil sampling methods. To develop suitable soil testing devices and soil testing methods. - -To collect and classify soils and their physical properties on the basis of fundamental knowledge of soil mechanics.
Weight-Volume Relations	2	Earth materials are three-phase systems. In most applications, the phases include solid particles, water and air. Water and air occupy voids between the solid particles. For soils in particular, the physical relationship between the solid particles. For soils in particular, the physical relationship between these phases must be examined. A mass of soil can be conveniently represented as a block diagram, with each phase shown as a separate block.
Permeability and Seepage	3	Settlement prediction (preloading), Seepage through and beneath earth structures such as earth dams and retaining walls, In designing of filters in which protect hydraulic structure from piping, Discharge of wells and To determine the amount of water that return into shallow and deep excavations during construction of a project.
Stress with in Soil Masses	4	developed the effective stress concept, which became a key concept in modern soil mechanics. Effective stress in soil contributes to its strength and volume change. It also influences the capillary rise, seepage force due to water flow, quicksand (sand boiling), and heaving at the bottom of the excavation. These are discussed in this chapter.
Total and Effective Stresses	6	The total vertical stress acting at a point below the ground surface is due to the weight of everything lying above: soil, water, and surface loading. Total stresses are calculated from the unit weight of the soil.
Principal Stresses	7	As with any other material, the normal stress at a point within a soil mass is generally a function of the orientation of the plane chosen to define the stress. It is meaningless to talk of the normal stress or the shear at a point.
Consolidation of Soil	9	soils layers undergo a certain amount of compression when subjected to any loading condition. This compression is due to deformation of soil particles, relocation of soil particles, expulsion of water or air from the void spaces.
Lateral Earth Pressure	10	Retaining structures such as retaining walls, basement walls, and bulkheads commonly are encountered in foundation engineering as they support slopes of earth masses. Proper design and construction of these structures require a thorough knowledge of the lateral forces that act between the retaining structures and the soil masses being retained. These lateral forces are caused by lateral earth pressure.
Improvement of Soil (Soil Stabilization by Admixtures) and Clay Minerals	12	The following geotechnical design criteria have to be considered during site selection. -Design load and function of the structure. -Type of foundation to be used. -Bearing capacity of subsoil. Clay minerals are very tiny crystalline substances evolved primarily from chemical weathering of certain rock-forming minerals.

Practical Topics	**Week**	**Learning Outcome**
Specific gravity of soil test	1	Specific gravity of soil is useful for determining weight volume relationships and It is used in the computation of most of the laboratory test; such as: hydrometer test, consolidation test.
Soil classification test Sieve analysis test Hydromater test	4	The object of classification is to arrange soils into groups according to certain characteristics and engineering behavior. Particles size, grading consistency and plasticity generally form the criteria for classification and the hydrometer analysis of soil, based on Stokes' law, calculates the size of soil particles from the speed at which they settle out of suspension from a liquid. Results from the test show the grain size distribution for soils finer than the No. 200 (75µm) sieve. However, when combined with a sieve analysis, offer a complete gradation profile of soils containing coarser materials.
Principles of liquid and plastic limits tests	5	This method covers the laboratory determination of the moisture content of a soil as a percentage of its oven-dried weight. The method may be applied to fine, medium and coarse-grained soils for particle sizes from 2 mm to > 10 mm.
Permeability test	6	The purpose of this test is to determine the permeability (hydraulic conductivity) of a sandy soil by the constant head test method. There are two general types of permeability test method that are routinely performed in the laboratory: 1. The constant head test method, and the falling head test method. The constant head test method is used for permeable soils. 2. The falling head test is mainly used for less permeable soils.
Soil compaction test , Standard Proctors compaction test	7	Laboratory compaction tests are used to determine the relation between water content and dry unit weight and to find the maximum dry unit weight and optimum water content.
Sand cone Method test	8	Find field density in highway or road construction**.**
CBR test	9	CBR is the ratio expressed in percentage of force per unit area required to penetrate a soil mass with a standard circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. The ratio is usually determined for penetration of 2.5 and 5 mm. When the ratio at 5 mm is consistently higher than that at 2.5 mm, the ratio at 5 mm is used.
Shear strength of soil test • Unconfined comparison soil • Triaxial compression test	11	The purpose of this laboratory is to determine the unconfinedcompressive strength of a cohesive soil sample. We will measure this with the unconfined compression test, which is an unconsolidated undrained (UU or Q-type) test where the lateral confining pressure is equal to zero (atmospheric pressure). The tri-axial shear test is most versatile of all the shear test testing methods for getting shear strength of soil i.e. Cohesion (C) and Angle of Internal Friction (Ø), though it is bit complicated. This test can measure the total as well as effective stress parameters both. These two parameters are required for design of slopes, calculation of bearing capacity of any strata, calculation of consolidation parameters and in many other analyses.

Consolidation test	12	Consolidation test is used to determine the rate and magnitude of soil consolidation when the soil is restrained laterally and loaded axially. The Consolidation test is also referred to as Standard oedometer test or One-dimensional compression test. This test is carried out on saturated soil specimens, especially in cohesive soils.

Questions Example Design

All questions are numerical and problem solving types. An example of a question paper and its solutions are attached at the end of this file.

Extra notes: Students can use internet for more explanation and getting extra examples.

External Evaluator

I hereby confirm that all syllabuses given in the attached course modules is sufficient to cover required subjects, areas and titles needed for students regarding the study year.

Ahmed Suad Ali:

Head of QA/QC committee + Senior scientific committee member of Highway Engineering Department/ 21-22

Sample of Exam

Ministry of Higher Education		**Class: Third**
& Scientific Research		**Subject: Soil Mechanics**
Erbil Polytechnic University		**Time : 3 hrs.**
Erbil Technical Engineering College		**Date : /2/2021**
Civil Engineering Department	**2020 - 2021**	**Code: HE301**
Note:	**Final Examination**	**2^{nd} Attempt**

(Theoretical part)

Qustion 1 **25 Marks**

Define the following mention below:

(Flow Lines, Plastic limit, Rock, Specific surface, Consolidation)

Question 2 **25 Marks**

saturated soil stratum 5m thick lies above an impervious stratum and below a pervious stratum. It has a compression index Cc= 0.25 and a coefficient of permeability = 3.2 * 10 cm/sec; its void ratio at a stress of 1.5 kg/cm² is 1.9, compute;

1. The change in void ratio due to increase of stress to 2 kg/cm².

2. settlement of the soil stratum due to the above increase in stress.

3. time (in min) for 50% consolidation. (Given Tv= 0.2)

Question 3 **25 Marks**

he setup shown below; plot to scale elevation head, pressure head, total head, and seepage velocity versus distance along the sample shown in figure-1.

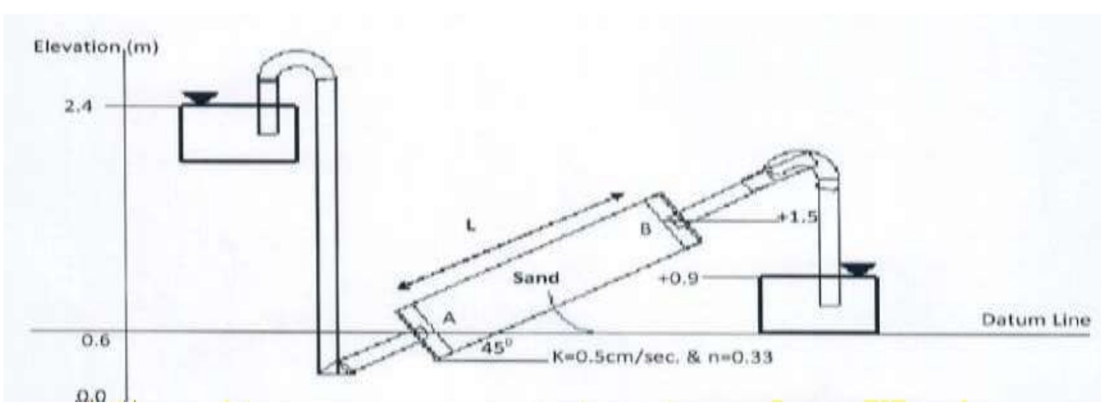


Figure-1

Question 4 **25 Marks**

h is required to be excavated from borrow pits for building an embankment as shown in the figure below. The moisture unit ht of the borrow pits is18 kN/m³ and its water content is 8%. Estimate the quantity of earth required to be excavated per meter th of embankment. The dry unit weight required for the embankment is 15 kN/m³ with a moisture content of 10%. Assume the ific gravity of solids as 2.67. Also determine the degree of saturation of the embankment soil and the volume of water in the ankment. (hint: Volume of embankment per meter length) shown in figure-2.

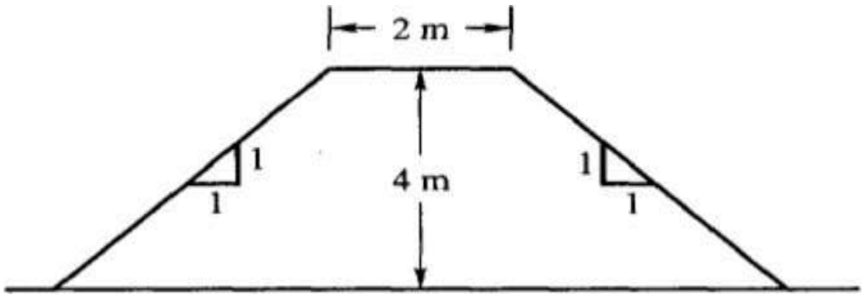


Figure-2

(Practical part)

Question 1 **10 Marks**

A. Wirt purpose Liquid, plastic, and specific gravity of soil?

B. Plot the particle size distributions for each of the soils whose sieve analyses are given below. Find D10, D30, D60 and select type of soil?

Sieve size, (mm)	Mass retained, sample 1	Mass retained, sample 2
37.5	0	15.5
20	0	17
14	0	10
10	0	11
6.30	4.2	33
3.35	3.1	114.5
1.18	55.1	63.3
0.60	26	18.2
0.20	10.4	17
0.063	1	10.5
pan	4.2	2.5

GOOD LUCK

Lecturer Name: Miss. Bafrin Chalabi

n = Vv/V Gt = ɣt / ɣw

S = (Vw / Vv)*100 e = n / 1- n

$e = Vv/Vs$	$n = e / 1+ e$
$W.C = (Ww/Ws)*100$	$\gamma t = \gamma d (W.C + 1)$
$Av = (Va/Vt)*100$	$\gamma d = (Gs / 1 + e) \gamma w$
$\gamma t= Wt/Vt$	$ht = hp + hz$
$\gamma d= Ws/Vt$	$\gamma d = Gs \gamma w (1 – n)$
$\gamma s= Ws/Vs$	$S e = Gs m$
$\gamma sub= \gamma sat - \gamma w$	$W.c = e S / Gs$
$Gs = \gamma s / \gamma w$	$A = n (1-S)$
$e = ((1+W.c) Gs \gamma w /\gamma d) – 1$	$\gamma t = \rho *g$
$PI = LL – PL$	$q = k (\Delta h/L)A$
$\sigma' = \sigma – u$	$\gamma sat = (Gs + e / 1 + e) \gamma w$
$\gamma d = (\gamma w / 1 + W.c.)$	
$Sc = \Delta e/(1+e0) * Ho$	$mv = (\Delta e/(1+e0)) * 1/\Delta p$
$Cc = \Delta e/\Delta \log p$	$Cv = K/(mv* \gamma w)$
$Tv = Cv t/ d^2$	

Question 1 **25 Marks**

Lines, indicating the direction of seepage down a hydraulic gradient (represent the path of water through a soil, the distance een two flow lines is a flow channel, these lines don't intersect).

tic limit, the plastic limit is defined as the moisture content at which the soil crumbles when it is rolled down to a diameter of one-th of an inch.

k, is a natural aggregate of mineral connected by strong and permanent coherence forces.

ific surface, Is the surface area per unit mass or volume.

solidation, when a saturated soil of low permeability is subjected to a compression stress, the pore water pressure, will ediately increase due to the low permeability of the soil, there will be a time lay between the load application and extrusion of the water and the compression.

stion 2 **25 Marks**

$Cc = \Delta e/\Delta \log p$ $0.25 = \Delta e / \log 2/1.5$ $\Delta e = 0.031$

$Sc = \Delta e/(1+e0) * Ho = 0.031 / 1 + 1.9 (5) = 0.054 m = 5.4 cm$

$Mv = (\Delta e/(1+e0)) * 1/\Delta p$ mv= 0.0215 cm²/kg

$Cv = K / mv * \rho w = 3.2 * 10 / 0.0215 *(1/1000)*1 = 14.85$ cm²/sec

14.85 * 60 = 891.317 cm²/min

$Tv = Cv\ t/ d^2 = 0.2 * 500 / 891.317 = 56$ min = t

stion 3 **25 Marks**

sin45 = 1.5 - 0.6 / L,   L = 1.272 m

Point	Elevation head he(m)	Pressure head hp (m)	Total head ht = he + hp (m)	Approach velocity v (cm/sec)
A	0	1.8	1.8	0.589
B	0.9	- 0.6	0.3	0.589

$i = \Delta ht / L = 1.8 - 0.3 / 1.272 = 1.178$

v = K i = 1.1785 * 0.5 = 0.58925 cm/sec

v= v / n = 0.589 / 0.33 = 1.785 cm/sec

Effective stress in soil with fluid flow

Elevation, m	v (KN/m²)бΔ	v (KN/m²)б	U (KN/m²)	бv' (KN/m²)
0.9		0	0	0
	0.3 * Ɣw = 2.94			
0.6		2.94	0.3 * Ɣw = 2.94	0
	0.6 * Ɣt = 12.54			
0		15.48	1.5 * Ɣw = 14.72	0.76

stion 4 **25 Marks**

A. Embankment

Vt = ½ * 4*4 + ½ *4*4 + 4*2 = 24cm³

ɣd = (Gs / 1 + e) ɣw = 15 = 2.67*9.81 / 1 +e   e = 0.746

e = vt – vs / vs = 0.746 = 24 – vs/vs   vs = 13.74 m³/m

borrow bit : ɣd = (ɣw / 1 + W.c.) = 18/ 1 + 0.08 = 16.67 kn/m³

ɣd = (Gs / 1 + e) ɣw = e = 0.57

e = vt – vs / vs = 0.57 = vt – 13.74 / 13.74   vt = 21.6 m³/m

B. S e = Gs m =   S = 2.67 * 0.1 / 0.746 = 0.358

C. n = e / 1+ e = 0.746 = 1 + 0.746 = 0.427

n = Vv/V = 0.427 * 24 = 10.25 m³/m

S = (Vw / Vv)*100   vw = 0.358 * 10.25 = 3.67 m³/m

Practical part

Question 1 **10 Marks**

A. The liquid limit test determines the liquid limit of a soil. By convention, the liquid limit is defined as the water content at which the groove cut into the soil pat in the standard liquid limit device requires 25 blows to close along a distance of 13 mm.

The plastic limit test is used to determine the lowest moisture content at which the soil behaves plastically, it is carried out only on the soil fraction passing No.40 sieve (425 micro) and is usually performed in conjunction with the liquid limit test.

1. Specific gravity of soil is useful for determining weight volume relationships.

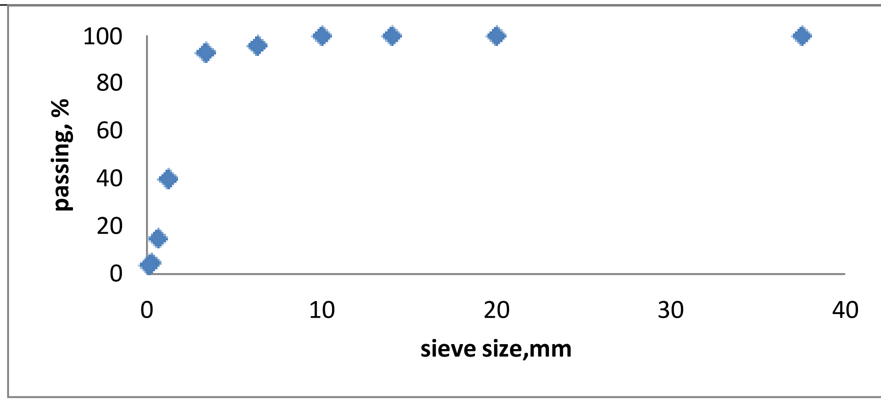
2. It is used in the computation of most of the laboratory test; such as: hydrometer test, consolidation test.

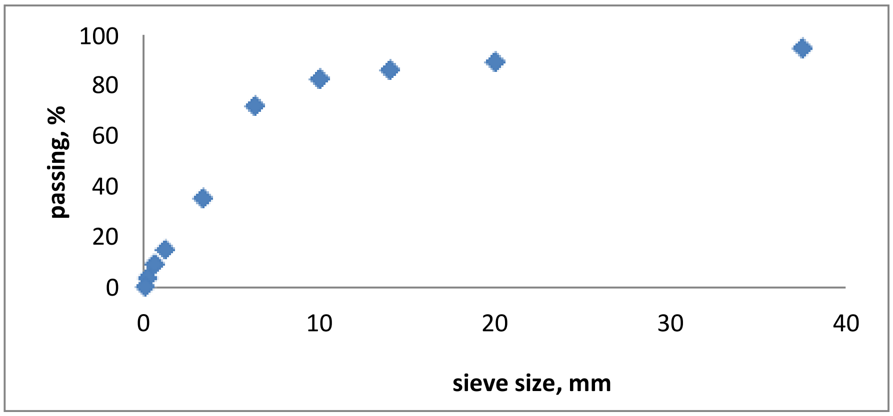
3. Specific gravity may be useful in soil mineral classification.

B.

Sieve size, (mm)	Mass retained, sample 1	Mass retained, sample 2
37.5	100	95
20	100	89.6
14	100	86.4
10	100	82.9
6.30	96	72.3
3.35	93	35.7
1.18	40	15.4
0.60	15	9.6
0.20	5	4.2
0.063	4	0.8
pan		

Cu = 1.8/0.36 = 5 Cu = 5.1 / 0.62 = 8.3


100
80
60
40
20
0
passing, %
0
10
20
30
40
sieve size,mm


100
80
60
40
20
0
passing, %
0
10
20
30
40
sieve size, mm