

**Soil Mechanics - Tutorial 2**  
**Theory**

1. Define phase diagram and derive the following relationship

$$\gamma_d = \frac{G_s \gamma_w (1 - n_a)}{(1 + wG)}$$

$$S_r = \frac{w}{\frac{\gamma_w}{\gamma} (1+w) - \frac{1}{G}}$$

$$S_r e = wG$$

$$\gamma = \frac{G + S_r e}{1 + e} * \gamma_w$$

Where all symbols stand for their usual meaning.

2. Write down the procedure for determining:
- Water Content
  - Specific Weight
  - Field Density
  - Liquid Limit
  - Plastic Limit
3. Write down the uses of particle size distribution curve.
4. Explain sedimentation analysis and hydrometer analysis in detail.
5. Determine the maximum possible void ratio for a uniformly graded soil. Also find the porosity.

**Numerical**

1. A clay sample containing its natural moisture content weighs 0.33 N. The specific gravity of solid of this soil is 2.70. After oven drying the soil sample weighs 0.2025 N. The volume of the moist sample before oven drying found by displacement of mercury is 24.30 cm<sup>3</sup>. Determine the moisture content, void ratio and degree of saturation of soil.
2. A soil sample was collected in a sampling tube of internal diameter 5cm and length 12cm. The weight of extracted sample was 420gms. On oven drying its weight was 380gms. Assume the specific gravity of soil grains to be 2.7. Determine:
- Bulk Unit Weight.
  - Water Content.
  - Void ratio.
  - Degree of saturation.

3. A sample of clay was coated with paraffin wax and its mass, including the mass of wax, was found to be 697.5 gm. The sample was immersed in water and the volume of water displaced was found to be 355 ml. The mass of the sample without wax was 690.0 gm, and the water content of the representative specimen was 18%. Determine the bulk density, dry density, void ratio and the degree of saturation. The specific gravity of the solids was 2.70 and that of the wax was 0.89.
4. A sample of soil with Liquid Limit of 72.8% was found to have a liquidity index of 1.21 and water content of 81.3%. Find plastic limit and plasticity index.
5. A pycnometer weighing 640gms was used in the following measurement on sample A and B of the same soil. Sample Aa was oven dried and B was completely saturated. Weight of pycnometer when filled with water was only 1495 gms.

Samples	A	B
Wt. of sample only (gms.)	1000	1344
Wt. of pycnometer full of soil sample and water	2125	2200

Find   i) The specific gravity of soil and  
          ii) The water content and void ratio of sample B.
6. Two soil C and D are mixed dry in proportion of 35%, 65% by mass. The specific gravity of soil C and D are 2.65 and 2.75 respectively. If the bulk density of mixed soil is 1.7 gm/cc at 15% water content, determine void ratio and degree of saturation.
7. The liquid limit and shrinkage limit of a soil sample are 50% and 16% respectively. If the volume of the specimen of this soil decreases, on drying from  $37.2\text{cm}^3$  at liquid limit to  $22.4\text{cm}^3$  at shrinkage limit, compute the specific gravity of soil particles.
8. In an oil drilling project, a heavy viscous liquid (drilling mud) was used to keep the drilling hole open. It consists of suspension in water of the following properties per litre of volume.

380gm of clay of  $G = 2.82$   
82gm of sand of  $G = 2.68$   
300gm of iron fillings of  $G = 7.13$

Assuming that unit weight of water = 1.00 gm per cc and a uniformly mixed suspension, what is the unit weight of suspension?
9. For a soil in natural state, given  $e = 0.8$ ,  $w = 24\%$  and  $G_s = 2.68$ . Determine the moist unit weight, dry unit weight and degree of saturation. If the soil is made completely saturated by adding water, what would be its moisture content at that time? Also find saturated unit weight. Notations have their usual meanings.

10. A natural soil deposit has a bulk unit weight of  $17 \text{ KN/m}^3$  and water content of 10%. Determine the amount of water required to be added to  $1 \text{ m}^3$  of soil to raise the water content to 15%. Assume void ratio remains constant.

11. The result of a liquid limit test is given below

<b>No of blows</b>	48	38	29	20	14
<b>Water content (%)</b>	32	35	40	46	52

- Determine the liquid limit of the soil.
- If the plastic limit of the soil be 23%, find the plasticity index, flow index and toughness index.

12. In a test to determine the liquid limit of silty clay the following results were recorded.

<b>Mass of container with wet soil (gm)</b>	19.62	21.26	19.5	21.28
<b>Mass of container with dry soil (gm)</b>	16.74	18.39	17.24	19.08
<b>Mass of container (gm)</b>	10.46	11.21	10.87	11.62
<b>Number of blows (N)</b>	12	19	28	41

Plot the result in graph paper and determine the liquid limit for the soil. If the plastic limit for the soil was 22% and natural water content 35%, find the plasticity index, liquidity index and consistency index.

13. 500g of dry soil was subjected to a sieve analysis. The weight of soil retained on each sieve is as follows:

<b>Sieve Size</b>	4.75mm	2mm	1mm	425 $\mu$	212 $\mu$	150 $\mu$	75 $\mu$	Pan
<b>Wt. of soil retained on sieve (g)</b>	10	165	100	85	40	30	50	20

Plot the grain size distribution curves and determine the following: a) Effective size b) Coefficient of uniformity c) Coefficient of curvature d) Gradation of soil.

14. A test for the determination for the liquid limit was carried on a soil sample. The following sets of observations were taken. Plot the flow curve and determine the liquid limit and the flow index.

<b>No. of blows (N)</b>	38	27	20	13
<b>Water Content (W%)</b>	47.50	49.50	51.90	53.90

15. Earth is required to be excavated from a borrow pit for building an embankment. The unit weight of undisturbed soil in wet condition is  $18 \text{ KN/m}^3$ , and its water content is 9%. In order to build a 4 m high embankment with top width 3m and side slope 2:1 (H:V), estimate the quantity of earth required to be excavated for 1m length of embankment. The dry unit

weight of embankment is  $15 \text{ kN/m}^3$ , with moisture content of 12%. Assume specific gravity of solids as 2.65.

16. Soil is to be excavated from a borrow pit which has a density of  $1.75 \text{ gm/cc}$  and water content of 12%. The specific gravity of soil particles is 2.7. The soil is compacted so that water content is 18% and the dry density is  $1.65 \text{ gm/cc}$ . For  $1000 \text{ cu.m.}$  of soil in the fill estimate:

- The quantity of soil to be excavated from the pit in  $\text{cu.m.}$
- The amount of water to be added.

Also determine the void ratio of the soil in borrow pit and fill.

17. A sand sample comprising of particles ranging from 0.2 to 0.05 mm is put on the surface of a still water tank of 3 m depth. Find the time required for the coarsest and the finest of the particles to reach the bottom of the tank. Assume specific gravity of soil solid as 2.7 and viscosity of water as 0.51 poise.