Questions

Theory

1. Define rock and soil. Describe the formation procedure of cohesive and cohesionless soil.
2. Define soil mechanics. Explain its importance in civil engineering with practical examples.
3. Explain rock cycle. Describe various types of soil in detail.
4. Why is soil a multi-phase material?
5. Define phase diagram and derive the following relationship

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

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

$$S_r e = wG$$

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

Where all symbols stand for their usual meaning.

6. Explain hydrometer analysis in detail.
7. Determine the maximum possible void ratio for a uniformly graded soil. Also find the porosity.
8. Compare the AASHTO classification system and Unified Soil Classification System.
9. Differentiate ISCS and USCS method of soil classification.
10. List out the methods for field identification of silt and clay. Describe dispersion test.
11. Explain the textural type of soil classification.
12. What are the purposes and requirements of soil classification?
13. Describe the type of soil structures that can occur in nature.
14. Explain about different types of clay minerals.
15. Define compaction. Describe standard proctor test and the modified proctor test. Draw typical moisture density graph and explain salient features of it.
16. What do you mean by compaction at dry of optimum and at wet of optimum?
17. Briefly mention the factors affecting compaction. What is relative compaction?
18. Describe the behavior of fine-grained soil when compacted at dry of optimum and wet of optimum.
19. Mention purposes of compaction. Differentiate between compaction and consolidation.
20. How can quality control of compaction be done in field? Explain.
21. Determine the method to obtain the coefficient of permeability of soil in an unconfined aquifer.
22. Define quick sand condition and derive the expression for critical hydraulic gradient in terms of specific gravity and void ratio.
23. Define permeability and describe well pumping test to obtain in-situ coefficient of permeability of soil in case of confined aquifer.
24. How can you determine the average permeability of a stratified soil deposit? Describe.
25. Quick sand is not a special type of soil. It is a hydraulic condition. Justify with expression of critical hydraulic gradient. Why is it mostly likely to occur in fine sand?

26. A cohesive soil does not become quick as soon as the effective stress is reduced to zero. Justify. Derive the critical hydraulic gradient for quick sand condition.
27. What are the assumptions of Laplace's equation? Prove that flow lines intersect equipotential lines at right angles.
28. Define flow lines and equipotential lines. Derive Laplace equation for two-dimensional flow making suitable assumptions.
29. What are the limitations of Boussinesq theory? Compare between Boussinesq and Westergaard theory. Show that the maximum value of vertical stress on a vertical plane occurs at a depth of $\frac{r}{z}$= 0.816.
30. Starting from Boussinesq's equation, derive an expression for vertical stress under a circular area of radius ' R' carrying uniformly distributed load of intensity 'q' per unit area.
31. Define Mohr – Coulomb failure critera. Using this criteria, derive obliquity equation.
32. What is meant by pre-consolidation pressure?
33. What is degree of consolidation? What do you know about hydrodynamic lag? Derive an expression for Terzaghi's theory of one-dimensional consolidation.
34. Why is unconfined compression test a special type of tri – axial test?
35. What is a stress path? Explain the vane shear test for determination of shear strength parameters of soil and also derive the expression for applied torque during one-way shearing.
36. What is meant by critical height of a slope?
37. Describe modes of slope failure.
38. Write short notes on:
    - Normally Consolidated Clay and Over Consolidated Clay
    - Stress Path
    - Stability Analysis of Finite Slopes
    - Onion Bulb Concept
    - Consistency Limit of Soils

Numerical

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

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

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

2. The result of liquid limit test is given below:

No. of blows	33	23	18	11
Water content %	41.5	49.5	51.5	55.6

   The plastic limits from two tests are 23 % and 24 % respectively. Determine plasticity index and toughness index for the soil.

3. 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^3. Determine the moisture content, void ratio and degree of saturation of soil.

4. 500g of dry soil was subjected to a sieve analysis. The weight of soil retained on each sieve is as follows:

Sieve Size	4.75mm	2mm	1mm	425µ	212µ	150µ	75µ	Pan
Wt. of soil retained on sieve (g)	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.

5. 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.

6. 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.

7. 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.

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

Mass of container with wet soil (gm)	19.62	21.26	19.5	21.28
Mass of container with dry soil (gm)	16.74	18.39	17.24	19.08
Mass of container (gm)	10.46	11.21	10.87	11.62
Number of blows (N)	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.

9. A natural soil deposit has a bulk unit weight of 17 KN/m^3 and water content of 10%. Determine the amount of water required to be added to $1m^3$ of soil to raise the water content to 15%. Assume void ratio remains constant.
10. Earth is required to be excavated from a borrow pit for building an embankment. The unit weight of undisturbed soil in wet condition is 18KN/m3, 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 kN/m3, with moisture content of 12%. Assume specific gravity of solids as 2.65.
11. 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.
12. 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 $37.2cm^3$ at liquid limit to $22.4cm^3$ at shrinkage limit, compute the specific gravity of soil particles.
13. 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.
14. 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:
   i) Bulk Unit Weight.
   ii) Water Content.
   iii) Void ratio.
   iv) Degree of saturation.
15. 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?
16. Soil is to be excavated from a borrow pit which has a density of 1.75 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 gm/cc. For 1000 cu.m. of soil in the fill estimate:
   - The quantity of soil to be excavated from the pit in cu.m.
   - The amount of water to be added.

   Also determine the void ratio of the soil in borrow pit and fill.
17. 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.

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

18. Classify the soils A and B with the properties as shown below, according to USC System.

Soil	**LL (%)**	**I_p (%)**	**% Passing No. 4 Sieve**	**% Passing No. 200 Sieve**
A	45	29	100	59
B	55	15	100	85

19. The sieve analysis of a given sample of soil gave information that 65% of the particle pass through 75-micron sieve. The following data has been obtained from liquid and plastic limit tests on the soil in the laboratory.

Details	**Liquid Limit Test Data**				**Plastic Limit**	
Mass of container with wet soil, (g)	43.35	47.5	45	44.95	43.62	40.38
Mass of container with dry soil, (g)	40.18	43.61	41.87	41.5	41.94	38.85
Mass of container only, (g)	29.86	31.5	32.05	30.51	33.1	30.9
Number of blows (N)	34	27	23	17		

Determine:

i) Liquid limit, Plastic limit and flow index.

ii) Classify the soil as per the Unified Soil Classification System.

iii) Liquidity index if the natural water content of the soil is 30%.

20. Find the group index value according AASTHO soil classification system by using following data. % passing 75-micron sieve = 58%, Liquid limit = 50%, Plastic Limit = 35 %.
21. The sieve analysis of a given sample of soil gave information that 60% of the particle pass through 75 micron sieve. The liquid and plastic limit of the soil were 62 and 28 percent respectively. Classify the soil as per USCS.
22. The sieve analysis of a given sample of soil gave information that 55% of the particle pass through 75-micron sieve. The liquid and plastic limit of the soil were 58 and 26 percent respectively. Classify the soil as per USCS.

23. Two soils were tested for their consistency in the lab. The following data were obtained.

Soil A		**Soil B**	
No of blows (N)	**Water Content (%)**	**No of blows (N)**	**Water content (%)**
8	43	5	65
20	39	15	61
30	37	30	59
45	25	40	58
Water content at which soil crumbled of 3mm diameter.	25%	Water content at which soil crumbled of 3mm diameter.	30%
Natural Water Content	40%	Natural Water Content	50%

Determine:

i) Which soil has greater plasticity?

ii) Which soil is more compressible in nature?

iii) Classify the both soils as per IS Classification System.

24. A sample of soil was tested in a laboratory, and the following observations were recorded.
Liquid Limit = 45 %

Plastic Limit = 16 %

U.S. Sieve No.	No. 4	No. 10 (2.0 mm)	No. 40 (0.425 mm)	No. 200 (0.075 mm)
Percentage Passing	100	91.5	80	60

Classify the soil according to AASHTO System.

25. Mechanical analysis on four different sample designated as A, B, C and D were carried out in a soil laboratory. The results of tests are given below. Hydrometer analysis was carried out on sample D. Soil is non-plastic.
Sample D: Liquid Limit = 42, Plastic Limit = 24, Plasticity Index = 18
Classify the soil as per the Unified Classification System.

Samples ASTM Sieve Designation	A (% finer than)	B (% finer than)	C	D
63 mm	100		93	
20 mm	64		76	
6.3 mm	39	100	65	
2.0 mm	24	98	59	
600 μ	12	90	54	
212 μ	5	9	47	100
63 μ	1	2	34	95
20 μ			23	69
6 μ			4	46
2 μ			7	31

26. The following are the results of a compaction test.

Mass of mould + wet soil (g)	2925	3095	3150	3125	3070
Water content (%)	10.0	12.0	14.3	16.1	18.2

Volume of mould = 1000 ml, Mass of mould = 1000 gm. Specific gravity of solids = 2.70.

i) Draw the compaction curve showing Optimum Moisture Content (OMC) and Maximum Dry Density.
ii) Plot the zero-air void line.
iii) Determine the degree of saturation at maximum dry density.

27. Given standard soil compaction test results as follows:

Trial No.	Moisture Content (% by dry weight)	Wet unit weight of compacted soil (KN/m^3)
1	8	19
2	10	21.2
3	11.4	21.9
4	12.6	21.1
5	13.9	20.2

The specific gravity of the soil particles is 2.65. Plot the following:

a) Moisture-dry density curve.
b) Zero air voids curve and
c) Ten percent air content curve (90% saturation curve).

28. The following data refers to a compaction test.

Water content (%)	8.5	12.2	13.75	15.5	18.2	20.2
Weight of wet sample (kg)	1.8	1.94	2.00	2.05	2.03	1.98

If the specific gravity of soil grains was 2.7.

i) Plot the compaction curve and obtain the maximum dry unit weight and the OMC.

ii) Plot the 80% and 100% saturation lines.

iii) If it is proposed to secure a relative compaction of 95% in the field, what is the range of water content that can be allowed.

iv) Would the 20% air voids curve be the same as the 80% saturation curve.

29. A sample of soil is prepared by mixing a quantity of dry soil with 10% by mass of water. Find the mass of this wet mixture required to produce a cylindrical compacted specimen of 15cm diameter and 12.5cm deep and having 6% air content. Find also the void ration and the dry density of the specimen if G = 2.68.

30. The following results were obtained from standard compaction test:

Mass of compacted soil (gm)	1929.5	2051.5	2138.5	2147	2128	2058
Water content (w %)	11	12.4	12.9	13.8	14.9	16.7

The specific gravity of soil solids is 2.65, and the vol. of mould is 1000cm3. Plot the compaction curve and obtain the maximum dry density and optimum moisture content. Plot also 0%, 5%, 10% air voids curves. At the maximum dry density, calculate the void ratio, degree of saturation and air content.

31. The following results were obtained from the sand replacement method:

Mass of soil extracted from the hole	4.0 kg
Water content of soil	18%
Mass of dry soil to fill the hole	3.1 kg
Mass of dry sand to fill container of volume 4.2 liters	5.8 kg

Calculate the wet and dry densities of the soil. If the specific gravity of the particles is 2.68, find the degree of saturation of the soil.

32. The insitu density of an embankment, compacted at a water content of 12% was determined with the help of core cutter. The empty weight of the cutter was 1286 gm and the cutter full of soil had a weight of 3195 gm, the volume of the cutter being 1000 cm^3. Determine the bulk density, dry density and the degree of saturation of the embankment. If the embankment becomes fully saturated during rains, what would be its water content and saturated unit weight? Assume no volume change in soil on saturation. Take the specific gravity of the soil as 2.7.

33. A laboratory constant head permeability test was conducted on a silty specimen of void ratio 0.45. The cylindrical specimen had a diameter of 7.3 cm and height of 16.8 cm. The head during the test was 75 cm. After 1 minute of testing at room temperature, a total of 775.6 gm of water was collected. Determine coefficient of permeability of soil. If void ratio changes to 0.38, What would be the percentage change in permeability?

34. In falling head permeameter test, the initial head (t=0) is 40 cm. The head drops by 5 cm in 10 minutes. Calculate the time required to run the test for the final head to be at 20 cm. If the sample is 6 cm in height and 50 cm^2 in x-sectional area, calculate the coefficient of permeability, taking area of stand pipe as 0.5 cm^2.

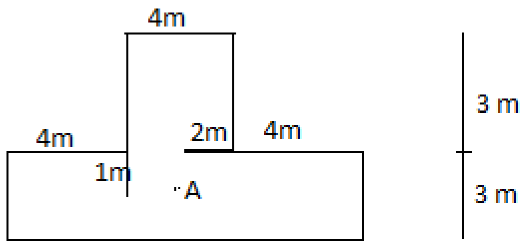
35. The capillary rise in soil A with D_{10} = 0.06 mm is 60 cm. Estimate the capillary rise in soil B with D_{10} = 0.1 mm. Assume the same void ratio in both the soils.
36. A 3 m thick soil stratum has a coefficient of permeability of $3*10^{-7}$ m/sec. A separate test gave porosity 40% and bulk unit weight 21KN/m^3 at a moisture content of 31%. Determine the head at which upward seepage will cause quick sand condition. What is the flow required to maintain critical condition?
37. Calculate the coefficient of permeability of soil sample 8 cm height and cross-sectional area 60 cm^2. It is observed that in 12 minutes, 600 ml of water passed down under constant head of 50 cm. The test specimen weighs 750 gm in dry condition. Take specific gravity of soil solids as 2.7. Calculate the seepage velocity.
38. A fine sand deposit is located between the ground surface to a depth of 10 m. The soil has an average void ratio of 0.70 and a specific gravity of 2.65. The water table is found at a depth of 4 m below the ground surface. Above the water table the degree of saturation of sand is 55 %. Determine the total stress, pore water pressure and effective stress at a depth of 8 m below the ground surface. Calculate also the change in the effective stress if the soil gets saturated upto a height of 1 m above the water table due to capillary.
39. A sand deposit consists of two layers. The top layer is 3m thick (ρ=1800 kg/m^3) and the bottom layer is 3.5m thick (ρ_{sat} = 2500 kg/m^3). The water table is at a depth of 4m from the surface and zone of capillary saturation is 1 m above the water table. Draw the diagram showing the variation of total stress, neutral stress (pore water pressure) and effective stress.
40. A horizontal stratified deposit consists of 3 layers with coefficient of permeability as $8*10^{-4}$ cm/sec, $50*10^{-4}$ cm/sec and $15*10^{-4}$ cm/sec and their thickness are 6m, 3m and 18m respectively. Find the effective average permeability of the deposit in horizontal and vertical direction.
41. In order to determine the average coefficient of permeability of a bed of sand 14 meters thick, overlying an impervious stratum, a well was sunk through the sand and a pumping test was carried out. After a certain interval, the discharge was 12.4 liters per second and drawn down in the observation wells at 16 meters and 33 meters respectively from the test well were found to be 1.787 m and 1.495 m respectively. If the GWT was originally 2.14m below the ground surface, find a) the permeability of sand layers, b) an approximate value for the effective grain size. (Take C = 125).
42. A layer of sand 6m thick lies beneath a clay stratum 5m thick and above a thick shale. In order to determine the permeability of the sand, a well was driven to the top of the shale and water was pumped out at the rate of $10*10^{-3}$ m^3/secs. Two observations well were driven through the clay at 15m and 30m from the pump well and drawn down in the wells were found to be 3m and 2.5m respectively. Calculate the coefficient of permeability of the soil.
43. A sand layer 10m thick overlies an impervious stratum. The water table is in the sandy layer at a depth of 1.5m below the ground surface. Water is pumped out from a well at the rate of 100 litres per second and the drawdown of the water table at a radial distance of 3m and 25m is 3m and 0.5m respectively. Determine the coefficient of permeability.
44. A 12m thick layer of relatively impervious stratum of clay lies over a bed of gravel aquifer. Piezometer tubes introduced to the level standing in the tubes 3 m above the top surface of the clay strata. The properties of the clay soil are e = 1.2 and G = 2.7. Determine: the effective stress at the top level of the gravel strata, the depth of excavation that can be made in the clay strata without the bottom heave.
45. A pumping test was made in a medium sand having depth of saturation 20m, where a bed of clay was encountered. The normal ground water table was at the surface. Observation wells were located

at 4m and 10m from the pumping well. At a discharge of 2m3/min. from the pumping well, a steady state was obtained in 24 hrs. The draw down at 4m well was 1 m and 10 m was 0.5m. Draw neat sketch and compute the permeability of the soil. If the draw down is 6m in the main well and dia of the tube-well is 30cm then what is the distance between center of the well and zero draw down.

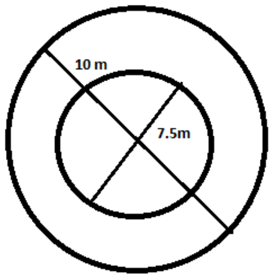
46. A concrete dam is constructed across a river over permeable strata of the soil of limited thickness. The water head on U/S side is 16m and 2m on the D/S side. The flow net constructed under the dam gives $N_f = 7$ and $N_d = 21$. Calculate the seepage loss through the subsoil if the average value of coefficient of permeability is $6*10^{-3}$ cm/sec horizontally and $3*10^{-6}$ cm/sec vertically. Calculate the exit gradient if the average length of the last field is 0.9m.
47. A sand deposit 10m thick overlies an impervious soil. A vertical sheet pile penetrates half way into the sand deposit. The water level on one side of the wall is 3.0m and on the other side is 0.5m above the ground level. The sand stratum has a vertical permeability of 1.44 m per day, and the horizontal permeability equals 8 times the permeability in the vertical direction. A flow net construction reveals that there are 12 flow channels and 26 potential drops. Determine the seepage flow per day.
48. A sheet pile wall is driven to a depth of 6m into permeable soil which extends to a depth of 13.5m below the ground level. Below this there is an impermeable stratum. There is a depth of water of 4.5m on one side of the sheet pile wall. Make a neat sketch of the flow net and determine the approximate seepage under the sheet pile wall in m^3/day, taking the permeability of the soil as $6*10^{-3}$ mm/secs.
49. Determine the co-ordinates of the phreatic line for the earth dam having top width=10m, Height of earth dam =35m, side slope = 2.5:1 (H:V), water height in U/S side =30m, water height at D/S surface =0, length of filter from toe =60m . Draw phreatic line and determine discharge through earth dam.
50. A soil stratum with permeability $k = 5*10^{-7}$ cm/sec overlies an impermeable stratum. The impermeable stratum lies at a depth of 18m below the ground surface (surface of soil stratum). A sheet pile wall penetrates 8m into the permeable soil stratum. Water stands to a height of 9m on upstream side and 1.5m on downstream side, above the surface of soil stratum. Sketch the flownet and determine:
    - i) Quantity of seepage.
    - ii) The seepage pressure at a point 'p' located 8m below surface of soil stratum and 4m away from the sheet pile wall on its upstream sides.
    - iii) The pore pressure at point 'p' and
    - iv) The maximum exit gradient.
51. A soil deposit consists of three horizontal layers of isotropic soils. The thickness of the top, middle and bottom layer is 3m, 4m and 5m respectively while the corresponding coefficient of permeability is $0.3*10^{-3}$ cm/sec, $0.4*10^{-3}$ cm/sec and $0.5*10^{-3}$ cm/sec respectively.
    - a. Determine the average (or equivalent) coefficient of permeability if the flow is parallel to the bedding plane and if it is perpendicular to the bedding planes.
    - b. If a concrete dam is to be constructed on the above soil deposit, what scaling adjustment has to be made before the construction of flownet? Draw sketch to clarify your answer. What will be the equivalent isotropic coefficient of permeability of the soil deposit?

Numerical

1. The plan of a foundation is shown in figure. The uniform pressure on the soil is 45KN/m^2. Determine the vertical stress increment due to the foundation at a depth of 4m below the point A. (2019 Fall)



2. A water tank is supported by a ring foundation having outer diameter of 10m and inner diameter of 7.5m. The ring foundation transmits uniform load intensity of 160KN/m^2. Compute the vertical stress induced at a depth of 4m below the



centre of ring foundation using
   a. Boussinesq analysis
   b. Westergaard's analysis (Take v=0.25) (2016 Fall)

3. A point load of 170 KN is applied at the ground surface. Construct the pressure bulb when the stress imposed becomes 25% of the applied load. (2016 Spring)
4. A raft foundation of 8m dia is placed on the ground surface and carries a load of 10000KN including self weight. Calculate the vertical stress increment at the centre of clay layer using Boussinesq's theory. The clay layer is 2m thick and it exists 5m below the ground surface. (2012 Fall)
5. A point load of 1200 KN is applied at the ground surface. Construct the stress contour when the stress imposed becomes 25% of the applied load. (2017 Fall)
6. A concentrated point load of 250KN acts at the ground surface. Find the intensity of vertical pressure at a depth of 5m below the ground surface at the point on the axis of loading using Boussinesq analysis. What will be the difference in vertical pressure at the same point if the load is shifted to a distance of 2m from its original position horizontally? (2015 Fall)
7. A ring footing of external diameter 8m and internal diameter 4m rests at a depth of 2m below the ground surface. It carries a load intensity of 150KN/m^2. Find the vertical stress at depths 2m and 4m along the axis of footing base. Neglect the effect of excavation on the stress. (2014 Fall
8. A water tower weighing 20000KN is to be considered as concentrated load acting on the ground surface. Compute the vertical stress at a depth 10m below the surface. Also compute the vertical stress at a distance of 8m away from the centre of water tower. (2015 Spring)
9. The plan of a three-legged tower forms an equilateral triangle of side 6m. If the total weight of the tower is 8000 KN and equally carried by all the legs. Compute the increase in vertical stress in the soil by the tower at a depth of 4.5m directly below the centre of equilateral triangle. (2012 Spring)

10. A ring footing of external dia 8m and internal dia 4m rests at a depth 2m below the ground surface. It carries a load intensity of 150KN/m^2. Find the vertical stress at a depth of 2m and 4m along the axis of footing base. Neglect the effect the excavation on the stress. (2014 Fall) (2011 Spring) (Ans: 36.63 KN/m^2 at depth 2m and 54.29 KN/m^2 at a depth 4m)

11. Two columns A and B are placed at 5m centre to centre. Through point A, a load of 400 KN is acting and from point B a load of 240KN. Calculate the vertical stress due to these loads on a horizontal plane 2m below the ground surfaces at points:
    a. Vertically below the points A and B
    b. 10m horizontally away from point A (2008 Fall)

(Ans: a. 48.56 KN/m^2, 28.98 KN/m^2 b. 0.015 KN/m^2)

12. Using Fadum's chart, determine the increase in vertical stress at 2m depth below A and B due to UDL of 40 KN/m^2 on the ground surface shown by the area in **fig2**. (21.02 KN/m^2, 8.98 KN/m^2) (2009Fall)
13. Find the vertical stress at 5m below point P due to UDL hatched area of 300 KN/m^2 intensity as shown in **fig 6**.
    (2.37 KN/m^2) (2014 Fall)

Additional Probable Questions

14. A point load of 1000 kN acts at a ground surface. Show the variation of vertical stresses on a horizontal plane at a depth of 5m below the surface.
15. A water tank in three pillars is in the form of an equilateral triangle in plan and the sides of the triangle are 10 metres. The total weight of water tower is 1000KN. Find the vertical stress 10m below the ground surface under any one of the legs.
16. A water tower has a circular foundation of diameter 9m. The total weight of the tower including the foundation is 17500KN. A very weak foundation capacity of 95KN/m^2 lies 3m below the foundation level. Calculate the stress due to foundation at the top of water stratum. Give your comment with regard to the feasibility of foundation construction at the top surface of the weak layer.
17. A concentrated load 800KN acts at the ground surface. Compute the vertical stresses at 8m depth:
    a. On the axis of load
    b. 2 m away from axis. Use Westergaard's analysis taking v=0.25.
    (Ans: 5.98 KN/m^2, 4.62 KN/m^2)
18. The load from a continuous footing of width 2m, which may be considered to be a strip load of considerable length, is 200 KN/m^2. Determine the vertical stress at 1.5m below the footing if the point lies directly below the centre of footing. (Ans: 133.42 KN/m^2)
    (hint σ: $\frac{q}{\pi}(2\theta+\sin 2\theta)$ ($\theta = \tan^{-1}(b/z)$) (b=B/2)
19. A strip footing of width 2m carries a load of 400KN/m. calculate the maximum stress at a depth of 5m below the centre line of footing. Compare the result with 2:1 distribution method. (49.53KN/m^2)
    (hint σ: $\frac{q}{\pi}(2\theta+\sin 2\theta)$ ($\theta = \tan^{-1}(b/z)$) (b=B/2) where θ is in radians.
    For 2:1 method, $\sigma=\frac{q*B}{B+z}$
20. A foundation of a building is rectangular in plan. It carries a uniform pressure of 25KN/m^2. Assuming the center of foundation as origin and Cartesian coordinates of the corners to be (5, 10), estimate the stress at depths of 20m below the ground surface at each of the following points: (0,10), (5,0), (5,10) and (7, 15).
21. A point load Q acts on the ground surface.
    a. Show the variation of vertical stresses on a horizontal plane at a depth of 2 m below the surface.
    b. Also show the variation of vertical stresses on a vertical plane at a radial distance r= 2m away from the applied load Q on the ground surface.
22. A rectangular foundation 2m * 1.5m carries a uniform load of 40 KN/m^2. Determine the vertical stress at P which is 3m below the ground surface as shown in **fig5**. Use equivalent point load method.
23. Two UDL of rectangular pattern with different load intensity are placed side by side on the ground as shown in the **figure 4**. Determine the vertical pressure due to the load below point A and B at a depth of 6m.(4.08 KN/m^2, 3.102 KN/m^2)
24. A UDL ABCDEF having a plan area as shown in **fig 3** is placed on the ground surface. The intensity of load is 20 KN/m^2. Determine the increase in vertical stress due to the load at 6m depth below the corner points C and D. (4.91 KN/m^2, 3.112 KN/m^2)
25. A strip footing is given in plan as shown in **fig 1**. The total load per unit area is 300 KN/m^2. Determine the intensity of vertical stress at a point 5m directly below the point A. (9.55t/m^2)
26. Determine the vertical stress at a depth of 4m below the raft foundation having size 20m*15m and the load on the raft is 30000KN. The depth of foundation is 3m and unit weight of soil is 17KN/m^3. The number of area units on Newmark chart is 105 if I_f =0.005. Also check the safeness of footing if bearing capacity of soil is 28KN/m^2. (Hint: σ= q_{net}*I_f*No. of area units, q_{net}= $(\frac{Q}{A} - \gamma * Z)$ (Ans: 27.7KN/m^2, Unsafe)

27. A rectangular area 4m*2m is uniformly loaded with a load intensity of 100 KN/m^2 at a ground surface. Determine the vertical pressure at a depth 3m below a point within the loaded area 1m away from the short edge and 0.5m away from long edge. Use equivalent point load method. (25.37 KN/m^2)
28. A raft foundation of 12m dia is placed on the ground surface and carries a load of 8000KN including self weight. Calculate the vertical stress increment at the centre of clay layer using Boussinesq's theory. The clay layer is 2m thick and it exists 7m below the ground surface.
29. The plan of a three-legged tower forms an equilateral triangle of side 7m. If the total weight of the tower is 6000 KN and equally carried by all the legs. Compute the increase in vertical stress in the soil by the tower at a depth of 3.5m directly below the centre of equilateral triangle.
30. A ring footing of external diameter 6m and internal diameter 2.5m rests at a depth of 2m below the ground surface. It carries a load intensity of 150KN/m^2. Find the vertical stress at depths 2m and 4m along the axis of footing base. Neglect the effect of excavation on the stress.
31. A water tower weighing 15000KN is to be considered as concentrated load acting on the ground surface. Compute the vertical stress at a depth 10m below the surface. Also compute the vertical stress at a distance of 6m away from the centre of water tower.

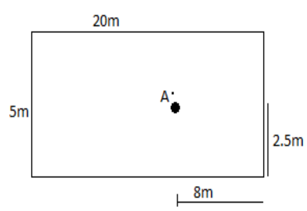


fig 1

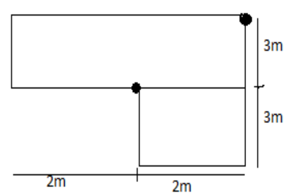


fig 2

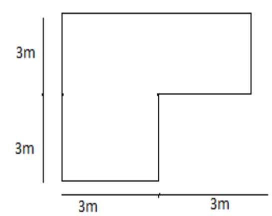


fig 3

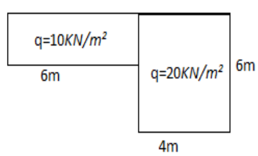


fig 4

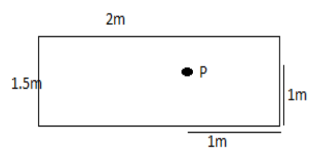


fig 5

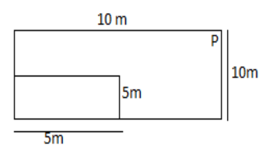


fig 6

32. A clay layer has a thickness of 5m and is subjected to a pressure of 60KN/m^2. If the layer has a double drainage and undergoes 50% consolidation in 1 year, determine the coefficient of consolidation taking T_v= 0.197. Also if the coefficient of permeability is 0.025m/year, determine the settlement in 1 year and rate of flow of water per unit area in 1 year. (2013 spring)
33. A stratum of clay is 2m thick and has an initial overburden pressure of 50KN/m^2 at its middle. Determine the final settlement due to an increase of 40KN/m^2 at the middle of the clay layer. The clay is over consolidated with a preconsolidation pressure of 75KN/m^2. The values of coefficient of recompression and compression index are 0.05 and 0.25 respectively. Take initial void ratio as 1.40.(Ans: 23.84mm) (2009 spring)
34. The consolidation settlement of a new structure founded on a 5m thick layer is estimated as 6.5cm. The structure was observed to have settled by 1.6cm in six months after the completion of construction. If the clay layer is underlain by rock and overlain by a layer of coarse sand. Determine :
    a. The time required for 50% consolidation
    b. The amount of settlement which will take place in the next six months. (2012 Fall)
35. A saturated soil stratum 5m thick lies above an impervious stratum and below a pervious stratum. It has a compression index of 0.3 and coefficient of permeability of $3.2*10^{-4}$cm/sec. it has a void ratio of 0.5 at a stress of 1.4kg/cm^2. Compute:
    a. The void ratio if the stress is increased to 2kg/cm^2
    b. Settlement of soil stratum due to above increased stress
    c. Time required for 80% consolidation. (2015 Fall)(2008 Fall DH)
36. A sand layer 5m thick lies over a clay layer 3.0m thick. The clay has saturated unit weight of 19KN/m^3 and has a compression index of 0.22. The initial void ratio of clay is 1.2. Calculate the final settlement of clay layer due to an increase in pressure of 35KN/m^2 at the centre of clay layer. Also calculate the settlement when the water table rises to the ground surface. (2015 spring) (2014 Spring) (2011 Fall)

37. A saturated soil stratum 6 metres thick lies above an impervious stratum and below a pervious stratum. It has a compression index of 0.28 and a coefficient of permeability of 3.5×10^{-4} cm/sec. Its void ratio at a stress of 150 kN/m^2 is 1.95. Determine:
    i) The change in void ratio due to an increase in stress to 210 kN/m^2.
    ii) Settlement of the soil stratum due to the above increase in stress.
    iii) Time required for 50 percent consolidation.

    Assume time factor T for 50 percent consolidation as 0.20.

37.

38. Find the time required for 50% and 80% consolidation in a soil stratum, 10m thick with a pervious stratum on top and bottom. Also find the coefficient of consolidation if, $K=1*10^{-9}$m/s, e_o= 1.5 and a_v= 0.003 m^2/KN. Symbols have their usual meanings. (667.625days, 1931.7 days, $C_v=8.497*10^{-8}m^2/sec$) (2016 Fall)
39. A consolidation test was performed on a 25mm thick undisturbed clay sample, 50% consolidation occurred in 5minutes. In the field, a clay layer is 2m thick and underlain by rock stratum. There is a sand layer above the clay layer. Determine the coefficient of consolidation. Also compute the number of days required for the field stratum to reach 50% consolidation. (2009 Spring)
40. Two clay samples A and B have initial void ratio of 0.55 and 0.632 respectively under pressure of $100KN/m^2$. The pressure increased to 150 KN/m^2. With the application of pressure, the void ratio decreases to 0.495 and 0.616 respectively. The time taken by sample A to reach 50% consolidation one third of the time required by sample B to reach the same consolidation. Find the ratio of coefficient of permeability of the specimen A and B if their thickness was 40 mm and 30 mm respectively. (19.3:1)
41. A 5m thick sand layer underlies a consolidated clay layer of 1m thickness. The water table is located on the ground surface. A 2m high soil embankment is laid on the ground surface in circular pattern having a diameter of 20m. The bulk unit weight of embankment sand and soil $17.5KN/m^3$ and 19 KN/m^3. The clay has a bulk unit weight of 17.5 KN/m^3, void ratio of 2.6 and compression index of 0.5. Calculate the settlement of clay layer beneath the center of embankment. (36.23mm)
42. A stratum of normally consolidated clay of thickness 3m is drained on both sides. If it has a coefficient of permeability k= $5*10^{-8}$cm/sec and coefficient of volume compressibility $125*10^{-2}cm^2/KN$. Determine the total compression of the strata for a change in stress of $25t/m^2$. Also determine the time required for 80% consolidation. (9.4cm, 36.9 days)
43. A soil deposit consists of upper layer of sand 6m thick underlain by a normally consolidated clay layer of 1m thick. The water table is 2m below the ground surface. Calculate the settlement of the clay if 1.5m thick backfill soil is dumped on the ground surface covering large area. The unit weight of the backfill is 18.5 KN/m^3 while that of the sand deposit is 18 KN/m^3. The clay soil has a bulk unit weight of 17.5 KN/m^3 and initial void ratio equal to 2.20. The compression index is 0.40. (17.75mm)
44. A clay layer of 1m thick is found between 6m and 7m below the ground surface. The clay layer is sandwiched between sand layers. The coefficient of volume change of clay is $0.40*10^{-3}m^2/KN$. A 3m high sand embankment of circular plan area of diameter 20m is placed on the ground surface. The unit weight of the sand is $20KN/m^3$. Determine the settlement of the clay layer under the center of the circular shape of radius r which can be calculated using the given formula

    $$\Delta\sigma = (1 - (\frac{1}{1+(\frac{r}{z})})^{1.5})*q$$
45. A 4m clay layer beneath a structure is underlain by rock and overlain by sand. The coefficient of consolidation of the clay was found to be $0.02cm^2/min$. The expected final settlement of the layer was 15cm. Determine the time taken for settlement of 5cm. How much time will it take for 80% final settlement to occur? (484.72 days, 3150days)
46. A soil deposit consists of a sand layer up to a depth of 5m underlain by a clay layer of 2m thickness. Water table was initially at ground surface but is lowered permanently by 2m. Determine the settlement at the centre of clay if the coefficient of volume compressibility is $0.25*10^{-3}m^2/KN$. (3.9cm)
47. A saturated clay stratum 4m thick lies above an impervious stratum and below a pervious stratum. It has a void ratio of 1.2 at an initial pressure of $200KN/m^2$. Compute the change in void ratio due to an increase in stress of 50 KN/m^2 assuming the soil is normally consolidated with compression index 0.2. What would be the time required for 50% consolidation? Take coefficient of permeability $=3*10^{-4}$cm/s. (29.67min)
48. A certain clay layer has a thickness of 5m. After 1 year, when the clay was 50%consolidated, 8cm of settlement had occurred. For similar clay and loading conditions, how much settlement would occur at the end of 1 year and 4 years respectively if the thickness of this new layer was 25m? (8cm, 16cm)
49. A compressible layer whose total settlement under a given loading is expected to 20cm settles 4cm at the end of 2 months. How many months will it take to reach the settlement of 10cm? Assume double drainage. (12.5 months)

50. A 25mm thick clay sample was used in oedometer consolidation test. During test it takes one month for 50% consolidation. If the same clay of 5m thickness is in between rock layer and sand layer in site, calculate the time required for 90% consolidation in site after construction of building in site. (692800 months)
51. A stratum of clay is 2m thick and has an initial overburden pressure of 50KN/m^2 at its middle. Determine the final settlement due to an increase in pressure of 40KN/m^2 at the middle of clay layer. The clay is overconsolidated with a preconsolidation pressure of 75KN/m^2. The values of the coefficient of recompression and compression index are 0.05 and 0.25 respectively. Take initial void ratio as 1.4. (23.84mm)

52. Following data were obtained from consolidation tests on two specimens A and B.

Pressure (KN/m^2)	Equilibrium Void Ratio	
	A	B
100	0.535	0.63
150	0.48	0.615

The initial thickness of specimen A was 30mm and that of B was 20mm. if the time taken for specimen A to reach 50% consolidation is one third of the time required by specimen B to reach the same degree of consolidation, find the ratio of coefficient of permeability of the two clay specimens. ($K_A : K_B$ = 26.28 : 1)

53. A consolidation undrained test was conducted on a clay sample and the following test results were obtained:

Cell Pressure (KN/m^2)	200	400	600
Deviator stress at failure (KN/m^2)	118	240	352
Pore water pressure at failure(KN/m^2)	110	220	320

Determine the shear strength parameters with respect to

a) Total stresses.
b) Effective stresses.

54. A soil sample was tested on lab by direct shear box test on a remoulded sand sample revealing the following information at the time of failure

Normal load =0.9KN
Shear load = 0.45 KN
Sample area= 36 cm^2
Determine:

a. The angle of internal friction
b. The magnitude and direction of principal stresses in the zone of failure. (2012 spring) (2012 fall) (2016 Spring) (2017 Fall)

55. A specimen of clean sand when subjected to direct shear test failed at a stress of 120KN/m^2 when the normal stress intensity was 160KN/m^2.

a. Determine the angle of internal friction
b. Deviator stress at which the failure will take place if a cylindrical sample of the same sand is subjected to a cell pressure of 100KN/m^2. Also find the angle made made by the failure plane with the horizontal. ($\emptyset = 35°, c = 300, \emptyset = 63.45°$) (2014 spring)

56. An unconfined cylindrical specimen of clay fails under an axial stress of 240 KN/m^2. The failure plane was inclined at an angle of 55 degrees to the horizontal. Determine the shear strength parameters of soil. (2014 Fall)
57. A direct shear test was conducted on a soil sample with cohesion of 10KN/m^2. The cross sectional area of sample was 60mm by 60mm. The normal load applied to the sample was 0.72KN. Determine:

a. The friction angle of soil if the shear load is 0.42KN
b. The shear force at failure if the same soil is subjected to a normal load of 1.44KN. (2015 Fall)

58. A consolidation undrained test was conducted on a clay sample and the following test results were obtained:

Cell Pressure (KN/m^2)	200	400	600
Deviator stress at failure (KN/m^2)	118	240	352
Pore water pressure at failure(KN/m^2)	110	220	320

Determine the shear strength parameters with respect to

a. Total Stresses
b. Effective Stresses (2015 Spring)

59. A consolidation undrained test was conducted on a clay sample and the following test results were obtained

σ_3 (KN/m^2)	150	300	450
$\sigma 1 - \sigma_3$ (KN/m^2)	192	341	504
U (KN/m^2)	80	154	222

Determine the shear strength parameters with respect to

a. Total Stresses

b. Effective Stresses (c=16kg/cm^2, $\emptyset = 29°$) (2011 Fall)

60. A sample of dry coarse soil is tested in the laboratory triaxial apparatus in the undrained condition under the cell pressure of 2kg/cm^2. The sample failed when the deviator stress reached 4.38 kg/cm^2. Determine the shear parameters of the soil. At what deviator stress will soil fail if the cell pressure be 3kg/cm^2? (2016 Fall)

61. The sand deposit in the field has an angle of shearing resistance of 34 degrees, dry density of 17KN/m^3, moist unit weight of 18KN/m^3 and saturated unit weight of 20KN/m^3. The water table is 1.5m below G.L. The sand is dry up to 1m depth and moist between 1 m and 1.5m depth. What is the shearing resistance on sand on a horizontal plane at a depth 2.5m below G.L.? (2010 spring)
62. A sample of dry cohesionless soil was tested in triaxial machine. If the angle of shearing resistance was 36 degrees and confining pressure was 100 KN/m^2, determine the deviator stress at which the sample failed. (2017 Spring)
63. The sand deposit in the field has an angle of shearing resistance of 34°, dry density of 17 KN/m^3, moist unit weight of 18KN/m^3 and saturated unit weight of 20KN/m^3. The water table is 1.5m below G.L. The sand is dry up to 1m depth and moist between 1m and 1.5m depth. What is the shearing resisting on sand on a horizontal plane at 2.5m depth below G.L.? (2012 Spring, 2010 Spring)
64. A direct shear box test performed on a remoulded sand sample yielding the following observations at the time of failure:
    Normal load= 0.36KN
    Shear load= 0.18KN
    Sample area= 36cm^2. Determine:
    a. Determine the angle of internal friction
    b. The magnitude and direction of principal stresses in the zone of failure
    c. The magnitude of deviator stress of the sample of same sand with same void ratio were tested in a triaxial test with all round pressure of 60KN/m^2. Assume c=0. (2008 Spring) (2010 Spring) (2012 Spring)
65. A direct shear box test performed on a remoulded sand sample yielding the following observations at the time of failure:
    Normal load= 0.9KN
    Shear load= 0.45KN
    Sample area= 36cm^2. Determine:
    a. The angle of shearing resistance.
    b. Angle which the failure plane makes with major principal axis.
    c. The magnitude and direction of principal stresses in the zone of failure
    d. Deviator stress.
66. A specimen of fine dry sand, when subjected to tri- axial compression test failed at a deviator stress of 500 KPa. It failed with a pronounced failure plane with an angle of 25° to axis of sample. Compute lateral pressure to which specimen would have been subjected.
67. In an unconfined compression test on an undisturbed sample, failure occurred under a vertical load of 12.85KN and axial deformation at the failure was recorded as 8mm. The diameter of soil sample was 38mm and height was 75 mm. It failed under a compressive load of 950N with a failure deformation of 12mm. Determine the unconfined compressive strength of soil in both cases where case one is undisturbed sample and case two is remoulded. Also find the sensitivity of soil. (1012N/cm^2, 70.37N/cm^2, 14.38) (2011 Spring)
68. An unconfined cylindrical specimen of clay fails under an axial stress of 240KN/m^2. The failure plane was inclined at an angle of 55°to the horizontal. Determine the shear strength parameters of soil. (2014 Fall) (2007 SpringDH)
69. A consolidation undrained test was conducted on a clay sample and the following test results were obtained
    σ_3=250KN/m^2
    σ_d= 275KN/m^2
    Determine:
    a. The angle of friction
    b. Angle which the failure plane makes with the major principal plane
    c. Normal stress and shear stress on the failure plane

70. A direct shear test was carried out on a cohesive soil sample and the following results were obtained.

Case	I	II
Normal Stress (kN/m^2)	150	250
Shear stress at failure (kN/m^2)	110	120

What would be the deviator stress at failure if a tri-axial test is carried out on the same soil with cell pressure of 150 kN/m^2.

71. Two triaxial tests were done on a soil sample. In the first test all round pressure was 2.4kg/cm^2 and failure occurred at axial stress of 7.5 kg/cm^2. In another test all round pressure was 4kg/cm^2 and failure occurred at total axial stress of 16 kg/cm^2. Determine the values of cohesion and angle of internal friction at failure. (c=0, $\emptyset = 36.5$)
72. An embankment is planned to be constructed from c= 4.0kg/cm^2 and c= 26kg/cm^2. Evaluate the shear strength of the material on the horizontal plane at a point 10m below the surface of embankment. The bulk density of soil is 2.3gm/cc and the pore water pressure at that point is 1.8 kg/cm^2.(4.244 kg/cm^2)
73. Two specimen of a soil were tested in a shear box. The following test results were obtained:

Normal load, kg	150	250
Shear stress, kg/cm^2	6.0	7.5

The test was done under undrained condition. Find the apparent cohesion and angle of shearing resistance of the soil. If on the same soil sample unconfined compresson was done, what will be the value of cohesion? The size of shear box was 5cm*5cm. (5.45 kg/cm^2)

74. A consolidation undrained test was conducted on a clay sample and the following test results were obtained

Confining pressure (kg/cm^2)	2	4
Deviator stress at failure(kg/cm^2)	5	9

Determine the shear strength parameters c and $\emptyset$ of the soil. ($\emptyset = 30°, c = 0.29$$kg/cm^2$)

75. In a triaxial shear test conducted on a soil sample having cohesion of 12 KN/m^2 and angle of shear resistance of 36°, the cell pressure was 200KN/m^2. Determine the value of deviator stress at failure. (617.46KN/m^2)
76. In a vane shear test conducted in a soft clay deposit failure occurred at a torque of 42 Nm. Afterwards the vane was allowed to rotate rapidly and the test was repeated in the remoulded soil. The torque at failure in the remoulded soil was 17Nm. Calculate the sensitivity of soil. In both cases the vane was pushed completely inside the soil. The height of vane and diameter across blades are 100mm and 80mm respectively. (0.033N/mm^2, 0.013N/mm^2, 2.54)
77. Two clay samples A and B have initial void ratio of 0.55 and 0.632 respectively under pressure of 100KN/m^2. The pressure increased to 150 KN/m^2. With the application of pressure, the void ratio decreases to 0.495 and 0.616 respectively. The time taken by sample A to reach 50% consolidation one third of the time required by sample B to reach the same consolidation. Find the ratio of coefficient of permeability of the specimen A and B if their thickness was 40 mm and 30 mm respectively.
78. A slope inclined at 16° to the horizontal to be made in cohesionless deposit having the following properties
G= 2.70 e= 0.72 $\emptyset = 35°$
Determine the factor of safety of slope against shear failure if water percolates in a direction parallel to the surface. (1.214) (2009 Fall)
79. A long natural slope in an overconsolidated clay ($\Upsilon_{sat} = 20KN/m3$ C'=10KN/m^2 and $\emptyset = 25°$) is inclined at 10° to the horizontal. The water table is at surface and seepage is parallel to the slope. If a plane of slip had developed at a depth 5m below the surface, determine FOS. Take unit wt of water= 10KN/m^3. (1.93) (2008 Fall)
80. A temporary cutting of 8m deep is to be made in a clay having an unit weight of 18KN/m^3 and an average cohesion of 20KN/m^2. A hard stratum rock exists at a depth of 12m below ground surface. Use Taylor stability chart to estimate the safety of 30° slope.
If FOS of 1.25 is considered necessary, find the safe slope angle.
(For D_f=1.5 and i=35°, S_n= 0.163)
(For D_f=1.5 and i=12°, S_n= 0.11) (2013 Spring)
81. An embankment 10m high is inclined at an angle 35° to the horizontal. A stability analysis by the method of slice gave the following force per unit length

$$\sum \text{Shearing force} = 440KN$$
$$\sum \text{Normal force} = 880KN$$
$$\sum \text{Neutral force} = 200KN$$

The length of failure arc is 26m. laboratory tests on soil indicated the effective values of C and $\emptyset$ as 20 KN/m^2 and 18° respectively. Determine FOS of slope with respect to

a. Shearing strength
b. Cohesion (1.68, 1.8) (2018 Fall)

82. An infinite slope is made of clay with following properties
$\Upsilon\ sat = 18KN/m^3$
$\Upsilon' = 9KN/m^3$
$C = 25N/m^3$
$\emptyset=28°$
If the slope has inclination of 35° and height equal to 12m, determine the stability of slope when
a. The slope is submerged
b. Seepage is parallel to slope
83. A canal is to be excavated at a depth of 6m below the ground level through a soil having following characteristics
G= 2.70 e= 0.9 $\emptyset = 20°$ $C=15KN/m^2$
The slope of bank is 1:1. Determine FOS with respect to cohesion when the canal is rapidly emptied completely.
For $\emptyset = 20°$ i=45 $S_n=0.062$
For $\emptyset = 9.35°$ i=45 $S_n=0.112$