

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZIANAGARAM**  
**III B. Tech I Semester Regular/Supplementary Examinations, April/May -2025**  
**GEOTECHNICAL ENGINEERING – I**  
(CIVIL ENGINEERING)

Time: 3 hours

Max. Marks: 70

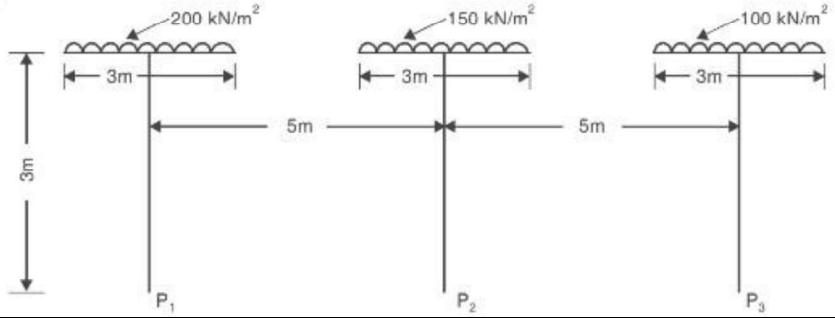
Answer any **FIVE** Questions **ONE** Question from **Each unit**

All Questions Carry Equal Marks

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\*The question paper mandates the use of normal graph paper\*

<b>UNIT-I</b>			
1.	a)	Sandy soil in a borrow pit has unit weight of solids as $26.3 \text{ kN/m}^3$ , water content equal to 11% and bulk unit weight equal to $16.4 \text{ kN/m}^3$ . How many cubic metre of compacted fill could be constructed of $3500 \text{ m}^3$ of sand excavated from the borrow pit, if the required value of porosity in the compacted fill is 30%? Also compute the change in degree of saturation.	[7M]
	b)	Differentiate between the Unified Soil Classification System (USCS) and Indian Standard Soil Classification System (ISSCS). How is a soil classified based on these systems?	[7M]
(OR)			
2.	a)	An undisturbed sample of saturated clay as a volume $16.5 \text{ cc}$ and weighs $35.1 \text{ g}$ . On oven drying, the weight of the sample reduces to $29.5 \text{ g}$ . Determine the void ratio and moisture content, dry density and specific gravity of solids.	[7M]
	b)	A laboratory compaction test on soil having specific gravity of 2.67 have a maximum dry density of $1.82 \text{ g/cc}$ and a water content of 17%. Determine the degree of saturation & air content & percentage air void at the maximum dry density. What will be the theoretical maximum dry density corresponding to zero air voids at the optimum water content.	[7M]
<b>UNIT-II</b>			
3.	a)	At a construction site, a 3m thick clay layer is followed by a 4m thick gravel layer which is resting on impervious rock. A load of $25 \text{ kN/m}^2$ is applied suddenly at the surface. The saturated unit weight of the soils is $19 \text{ kN/m}^3$ and $20 \text{ kN/m}^3$ for the clay and gravel layer respectively. The water table is at the surface. Draw diagrams showing variation of total, neutral and effective stress across the depth in the soil layers.	[7M]
	b)	In a falling head permeability test, the initial head ( $t=0$ ) is 40cm. The head drops by 5cm in 10 minutes. Calculate the time required to run the test for the final head to be at 20cm. if the sample is 6cm in height and $50 \text{ cm}^2$ in cross section area, Calculate the coefficient of permeability. Taking the area of stand pipe as $0.5 \text{ cm}^2$	[7M]
(OR)			
4.	a)	A granular soil deposit is 7m deep over an impermeable layer. The ground water table is 4m below the ground surface. The	[7M]

		deposit has a zone of capillary rise of 1.2m with a saturation of 50%. Plot the variation of total stress, pore water pressure & effective stress with the depth of deposit. Take $e=0.6$ & $G_s=2.65$ .	
	b)	Calculate the coefficient of permeability of a soil sample 6m in height & 50cm <sup>2</sup> in cross-sectional area, if a quantity of water equal to 450mm passed down in 10 minutes under an effective constant head of 40cm. On over drying the test specimen weighs 495g. Taking the specific gravity of soil solids as 2.65, Calculate the seepage velocity of water during the test.	[7M]
		<b>UNIT-III</b>	
5.	a)	Describe in detail the assumptions, derivation (basic form), and significance of Boussinesq's theory for determining vertical stress due to a point load on a homogeneous, isotropic, elastic half-space. How is this theory extended to calculate stress under loaded circular and rectangular areas?	[7M]
	b)	A rectangular area 2 m x 4 m carries a uniform load of 80 kN/m <sup>2</sup> at the ground surface. Find the vertical pressures at 5 m below the centre and corner of the loaded area by equivalent point load method.	[7M]
		(OR)	
6.	a)	What is Newmark's influence chart? Explain its construction and use in determining vertical stress distribution under loaded areas. Compare its advantages with analytical methods like Boussinesq's and Westergaard's theories.	[7M]
	b)	Three parallel strip foundations each 3 m wide 5 m apart centre to centre transmit contact pressures of 200 kN/m <sup>2</sup> , 150 kN/m <sup>2</sup> and 100 kN/m <sup>2</sup> respectively. Calculate the intensity of vertical stress due to the combined loads beneath the centre of each footing at 3 m depth. Use Boussinesq line load approximation.	[7M]
			
		<b>UNIT-IV</b>	
7.	a)	Two clay specimens A and B, of thickness 2 cm and 3 cm, have equilibrium voids ratios 0.68 and 0.72 respectively under a pressure of 200 kN/m <sup>2</sup> . If the equilibrium voids ratios of the two soils reduced to 0.50 and 0.62 respectively, when the pressure was increased to 400 kN/m <sup>2</sup> , find the ratio of the co-efficients of permeability of the two specimens. The time required by the specimen A to reach 40 per cent degree of consolidation is 1/4 of that required by specimen B for reaching 40% degree of consolidation.	[7M]
	b)	A 20 m thick isotropic clay stratum overlies an impervious rock. The coefficient of consolidation of soil is $5 \times 10^{-4}$ cm <sup>2</sup> sec.	[7M]

		<p>(i) Find the time required for 50% and 90% consolidation. Time factor for <math>U = 50\%</math> is 0.2 and for <math>U = 90\%</math> is 0.85, where <math>U</math> is the degree of consolidation.</p> <p>(ii) In order to accelerate the settlement ratio, vertical sand drains of 1 m diameter were made at 5 m centre to centre in the soil stratum throughout the area.</p> <p>Calculate how much the settlement is accelerated due to provision of sand drains. For the provided ratio of five between the spacing of sand drains (centre to centre) and diameter of drains, values of time factor for <math>U = 50\%</math> is 0.078 and for <math>U = 90\%</math> is 0.28.</p>	
		(OR)	
8.	a)	A clay layer, whose total settlement under a given loading is expected to be 12 cm settles 3 cm at the end of 1 month after the application of load increment. How many months will be required to reach a settlement of 6 cm? How much settlement will occur in 10 months? Assume the layer to have double drainage.	[7M]
	b)	<p>i) A laboratory compaction test on soil having specific gravity equal to 2.68 gave a maximum dry density of <math>1.82 \text{ g/cm}^3</math> and a water content of 17 per cent. Determine the degree of saturation, air content and percentage air voids at the maximum dry density. What would be theoretical maximum dry density corresponding to zero air voids at the optimum water content?</p> <p>ii) A cohesive soil yields a maximum dry density of <math>1.8 \text{ g/cc}</math> at an OMC of 16% during a standard proctor test. If the value of <math>G</math> is 2.65, what is the degree of saturation? What is the maximum dry density it can further compacted to?</p>	<p>[4M]</p> <p>[3M]</p>
		<b>UNIT-V</b>	
9.	a)	Two identical specimens, 4 cm in diameter and 8 cm high, of partly saturated compacted soil are tested in a triaxial cell under undrained conditions. The first specimen failed at an additional axial load (i.e., deviator load) of 720 N under a cell pressure of $100 \text{ kN/m}^2$ . The second specimen failed at an additional axial load of 915 N under a cell pressure of $200 \text{ kN/m}^2$ . The increase in volume of the first specimen at failure is 1.2 ml and it shortens by 0.6 cm, at failure. The increase in volume of the second specimen at failure is 1.6 ml, and it shortens by 0.8 cm at failure. Determine the value of apparent cohesion and the angle of shearing resistance (a) analytically, (b) graphically by Mohr's circle.	[7M]
	b)	In a formation of cohesionless soil, the water table is at a depth of 3 m. The degree of saturation may be taken as 0.5 on the average void ratio 0.5; grain specific gravity 2.70; angle of internal friction = $30^\circ$ . Calculate the potential shear strength on a horizontal plane at a depth of 2.5 m below the surface. Also, calculate the modified value of the shear strength if the water table reaches the ground surface.	[7M]
		(OR)	
10.	a)	Calculate the potential shear strength on a horizontal plane at a	[7M]

		depth of 3 m below the surface in a formation of cohesionless soil when the water table is at a depth of 3.3 m. The degree of saturation may be taken as 0.5 on the average; void ratio = 0.5; grain specific gravity = 2.7; angle of internal friction = $30^\circ$ . What will be the modified values of shear strength if water table reaches the ground surface?	
	b)	Laboratory results on a soil have shown that its unconfined compressive strength is $1.2 \text{ kg/cm}^2$ . In a triaxial compression test, a specimen of the soil when subjected to a chamber pressure of $0.4 \text{ kg/cm}^2$ failed at an additional stress of $1.6 \text{ kg/cm}^2$ . Estimate the shearing strength of the same soil along a horizontal plane at a depth of 4 m in a deposit. The ground water table is at a depth of 2.5 m from the ground level. Take dry unit weight of soil as $1.7 \text{ g/cc}$ and specific gravity as 2.7.	[7M]

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