Scoring Indicators

COURSE NAME: GROUND IMROVEMENT TECHNIQUE

VERSION: B

COURSE CODE: (15) 6017 **QID: B**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**10**
I. 1	**Compaction** is a process by which the soil particles are artificially arranged and packed together into a closer state of contact by mechanical means to decrease the void ratio of the soil and thus increase dry density	2	2	
I. 2	Soil stabilization is defined as a chemical, physical, biological, mechanical, or combined technique that maintains or improves the stability of weak soils to achieve engineering goals.	2	2	
I. 3	Reinforced soil- A soil soil that is strengthened by tensile elements as reinforcements such as metal strips, geotextiles, or geogrids.	2	2	
I. 4	Geosynthetics are one of the most revolutionary product groups within civil engineering, offering high-performance, cost-effective and long-term solutions to problems that arise within geotechnical, geo-environmental, hydraulic and transportation engineering.	2	2	
I. 5	$\tau_f = c + \sigma \tan\phi$ Where: c = cohesion; ϕ = angle of internal friction; σ = normal stress on the failure plane; τ_f = shear strength	2	2	
	PART B			30
II. 1	Ground improvement is carried out for various objectives: to improve bearing capacity and reduce settlement of soft ground, prevent earthquake liquefaction, control groundwater, stabilize excavation bottom, prevent deformation of surrounding ground, or clean up contaminated ground.	Any 6	6	

II. 4	Grouting materials Based on physical properties along with strength , grouts are classified as Course and fine grouts Course grouts : -Particulate grouts, Penetrability is dependent on the particle size Fine Grouts : Low viscous chemical grouts are termed as fine rained groutsPenetrability is a function of gel time and initial viscosity Cement based grouts such as neat cement, cement admixture, cement sand grouts are used Helps reducing the mass permeability and increasing the strength of natural formations •Types Neat cement Cement with bentonite Cement sand grout Cemnt bentonite clay Cement with fly ash Cement with chemical admixtures **Chemical based fine grout** In this chemicals are introduced at high pressure. Chemical grouts are more expensive than cement grouts. Since there are no granular material, can be injected into any formations with a reasonable sized opening. Require less pumping pressure-low viscosity.	6	6	
II. 5	Some of the applications of reinforced earth include its use in stabilization of the soil by increasing the California bearing ratio of the soil. It can also be used to construct retaining walls and bridge abutments for highway and railway applications. It is applied in control of erosion.	6	6	

II. 2	The various types of soils can be compacted in the field by three methods **1. Rolling** **2. Ramming** **3. Vibration** Corresponding to these various compacting equipment can be grouped Under three categories **Rollers, Ramming equipment and Vibrating equipment** • The rolling equipments are of five types ❖ Smooth-wheel roller (drum) ❖ Pneumatic tyred roller ❖ Sheepsfoot rollers ❖ Lorries and Pneumatic tyred construction plant Track laying vehicles	6	6	
II. 3	**Cement Stabilization:** Cement stabilization is a construction and geotechnical engineering technique that involves mixing cement into soil to improve its engineering properties. This process enhances the soil's strength, durability, and workability, making it suitable for a variety of construction applications. **Purpose:**Cement stabilization is primarily used to modify the properties of soil, improve the load-bearing capacity, reduce settlement, and increase the durability of the treated soil. 1. **Materials:** • Portland cement is the most commonly used cementitious material for stabilization. It is mixed with the soil in predetermined proportions. **Process:** • The cement and soil are mixed together thoroughly, either in situ (on-site) or in a central mixing plant, to achieve a homogeneous mixture. • The mixture is then compacted to the desired density, often using heavy construction equipment like compactors or rollers. • Water may be added to achieve the optimum moisture content for compaction.	6	6	

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<tr><td>II. 6</td><td>Geosynthetics have been successfully used to fulfill a number of functions that contribute significantly to the good performance of roadways. They include the functions of separation, filtration, reinforcement, stiffening, drainage, barrier, and protection.</td><td>6</td><td>6</td><td></td></tr>
<tr><td>II. 7</td><td><table>
<tr><td>Consolidation:</td><td>Compaction:</td></tr>
<tr><td>process that primarily deals with the expulsion of air and water from the soil</td><td>by the elimination of air voids in a relatively short period.</td></tr>
<tr><td>Slow process</td><td>Quick process</td></tr>
<tr><td>Loading is static and constant.</td><td>Loading is applied in a dynamic way.</td></tr>
<tr><td>It begins naturally along with the construction work.</td><td>It is done before the construction of structure.</td></tr>
<tr><td>Only cohesive soil is preferred</td><td>Preferred for both cohesive and cohesionless soil</td></tr>
<tr><td>Occurs naturally</td><td>Done artificially to improve the density</td></tr>
</table></td><td>6</td><td>6</td><td></td></tr>
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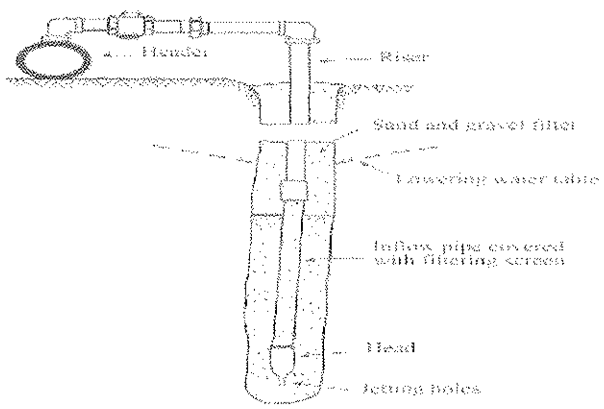
	PART C			60
III. a)	**Vacuum Method of Dewatering:** The vacuum method of dewatering is a method to remove water from the ground, typically in excavations, tunnels, and construction sites where groundwater ingress is a significant concern. This method involves the use of vacuum pumps and wells to create a pressure differential that draws water out of the ground. 1. **Principle of Operation**: The vacuum dewatering method relies on the principle that lowering the air pressure within a well or a system of wellpoints can reduce the water table and induce the flow of groundwater toward the lower pressure zone. 2. **Components**: **Vacuum Pump**: A vacuum pump is the core component of the system. It creates the low-pressure environment within the wellpoints or wells, causing water to rise and be drawn out. **Wellpoints**: These are small-diameter, perforated pipes or tubes that are installed in the ground around the area to be dewatered. They are connected to the vacuum pump. • **Header Pipe**: Wellpoints are connected to a header pipe, which, in turn, is connected to the vacuum pump. • **Control System**: A control system regulates the vacuum level and manages the dewatering process, including monitoring groundwater levels.	7	7	7
b)	**Well Point System OF DEWATERING:** **Diagram**  Fig 1 Single Stage Well Point A well point system is a commonly used method for dewatering excavations, construction sites, and foundations where groundwater needs to be lowered to facilitate construction or	Fig -3 Exp -5	8	8

	prevent water infiltration. It involves the installation of a series of closely spaced well points, connected to a vacuum or suction pump, to lower the groundwater table in the vicinity of the excavation. Here's an explanation of the well point dewatering system: ***Components of a Well Point System:*** 1. **Well Points**: Well points are small-diameter pipes (typically 1 to 2 inches in diameter) with screened openings at the bottom. These screens prevent soil particles from entering the well point while allowing water to flow in. Well points are driven or jetted into the ground and are spaced closely together along the perimeter of the excavation. 2. **Header Pipe**: A header pipe is a larger-diameter pipe connected to the well points. It collects the water from the well points and conveys it to a central collection point. 3. **Vacuum Pump**: A vacuum or suction pump is used to create a negative pressure or vacuum in the header pipe. This vacuum lowers the groundwater table around the well points, causing water to flow into the system.			
IV. a)	• To keep working place dry like excavation for dams, building foundations and tunnels. • To stabilize natural or constructed slopes • To treat granular soils by reducing their compressibility • To decrease lateral pressures on retaining walls or foundation • To improve bearing capacity of foundation soils • To improve hauling characteristics or workability of the borrow materials • To reduce liquefaction susceptibility due to upward gradient • To reduce liquefaction potential due to seismic activity • To prevent migration of soil particles by groundwater • To reduce surface erosion.	Any 7	7	7

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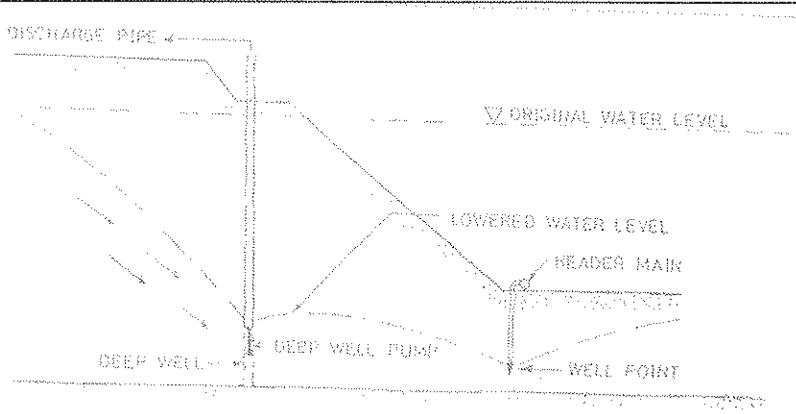

Deep well drainage system consists of deep wells and submersible turbine pumps which can be installed outside the zone of construction.
Deep wells are usually spaced from 8 to 80m depending upon the level to which water table must be lowered, permeability of the sand stratum, source of seepage and amount of submergence available.

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<td>Fig – 3
Exp -5</td>
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<td>V.</td>
<td>a)</td>
<td>
Bituminous Soil Stabilization :

Soil stabilization using bitumen, often referred to as bituminous soil stabilization, is a common technique employed in civil engineering and road construction to improve the engineering properties of soil materials. This process involves the addition of bituminous materials, such as bitumen or asphalt, to native soils to enhance their strength, durability, and resistance to water infiltration.

Materials and Equipment:

Bituminous Binder: This can be in the form of bitumen (asphalt) or bituminous emulsions. The choice of binder depends on project requirements, local availability, and environmental considerations.
Soil: The native soil to be stabilized should be thoroughly tested for its characteristics, including gradation, plasticity, and moisture content.
Compaction Equipment: Compactors, such as vibratory rollers or pneumatic tire rollers, are used

Procedure for Soil Stabilization Using Bitumen:
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	1. **Soil Analysis**: Conduct a comprehensive analysis of the native soil to determine its properties and characteristics. This includes gradation analysis, Atterberg limits (liquid limit, plastic limit), and moisture content testing. 2. **Design Mix**: Based on the soil analysis, design a bituminous mix that specifies the type and percentage of bituminous binder to be added to the soil. Generally, bitumen percentages for soil stabilization can range from 5% to 14% or more. 3. **Preparation of Bituminous Binder**: Heat and liquefy the bitumen to the specified temperature range (typically between 140°C and 160°C) to achieve proper mixing and coating of the soil particles. 4. **Mixing**: Introduce the bituminous binder into the soil using a pug mill, mechanical mixer, or in-place mixing equipment. The mixing process should be thorough to ensure that the binder coats the soil particles uniformly. 5. **Compaction**: Place the mixed material in the desired location and compact it using heavy compaction equipment. Achieve the specified compaction density to ensure adequate strength and stability. 6. **Curing**: Allow the stabilized soil to cure for a specified period, which can vary depending on the type of bitumen used and the environmental conditions. This curing period allows for the binder to set and bond with the soil particles. 7. **Quality Control**: Conduct quality control tests, including density, moisture content, and strength tests, to ensure that the stabilized soil meets the project's specifications.			
b)	Grouting is a versatile construction and geotechnical engineering technique used for various applications to enhance the stability, durability, and functionality of structures and subsurface environments. 1. **Foundation Support and Underpinning**: 2. **Soil Stabilization**: 3. **Tunneling and Underground Construction**: 4. **Dams and Reservoirs**: 5. **Groundwater Control**: 6. **Soil Improvement**: 7. **Pipeline and Utility Duct Sealing**: 8. **Rock and Soil Anchoring**: 9. **Cavity and Void Filling**: **10 Concrete Repair and Crack Injection**	8	8	8

VI. a)	Mechanical stabilization is the process of altering soil properties by changing the gradation through mixing with other soils, densifying the soils using compaction efforts, or undercutting the existing soils and replacing them with granular material. Explain with procedure	7	7	7
b)	• Jet grouting is used as replacement technique, unlike other conventional injection methods. • This method consists of lowering a drill pipe into a borehole. • Drill pipe is specially designed which simultaneously conveys pumped water, compressed air and grout fluid. • At the bottom end of the pipe two nozzles are provided at 500 mm apart. • Upper nozzle delivers pressurized water to produce a cutting jet. • Grout is delivered through the lower nozzle. • Stem is slowly raised, whereby the excavated materials from the jetting action is replaced by the grout and forced to the surface.	Fig-3 Exp-5	8	8

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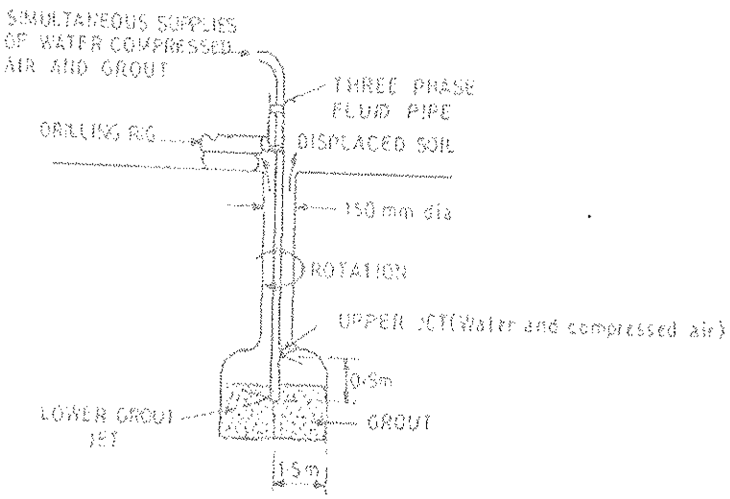
<tr><td></td><td>
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<tr><td>VII. a)</td><td>Sequence of construction of RE wall
• <u>Excavation:</u> Earthwork in the excavation of soil for reinforced soil Wall (RS Wall) shall be as per construction drawing. After soil excavation, compaction should be done to avoid any kind of settlement in foundation soil.
• <u>Levelling Pad:</u> An initial levelling pad of 150 mm thick using M20 grade plain cement concrete having a suitable width(300-350mm) to be provided below the first row of fascia layer.
• <u>The first layer of facia:</u> It should be as per the design and drawing. During the first layer of facia placement, utmost care should be taken to maintain the alignment of the facing element.
• <u>Drainage material:</u> Drainage material/filter media specification should be as per the design requirement. Drainage layer should be well compacted, and which is constructed in a layer-wise.
• <u>Placing of Reinforced soil behind drainage bay/filter media:</u> Placing the reinforced soil backfill behind the drainage zone and compacting the same.</td><td>7</td><td>7</td><td>7</td></tr>
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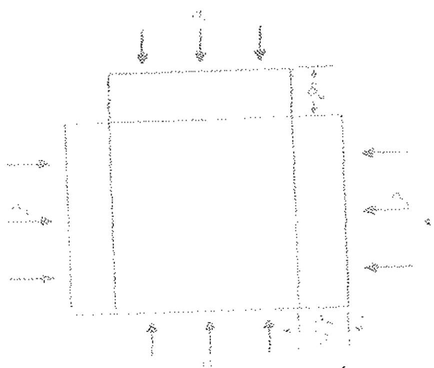
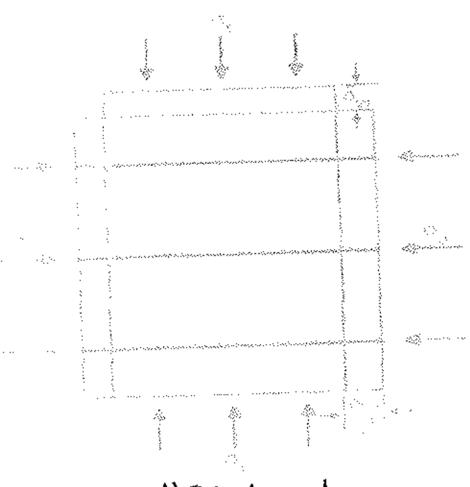
	b)	The various fields of applications of geosynthetics: 1. **Soil Erosion Control**: 2. ***Road and Pavement Construction***: 3. **Retaining Walls and Slope Stability**: 4. **Landfills and Waste Management**: 5. **Water Management and Drainage**:. 6. **Pond and Reservoir Liners**: 7. **Coastal and Marine Engineering**: 8. **Railway and Airport Pavements**: 9. **Geotechnical Engineering**: 10. ***Vegetated Reinforcement***: 11. **Agriculture and Aquaculture**: 12. **Tunneling and Mining**:	List-2 Exp-6	8	8
VIII.	a)	1. **Geogrids**: • **Description**: Geogrids are synthetic materials with a grid-like structure made of polymers, such as polyester or polypropylene. • **Function**: They are used to improve soil stability, reduce soil settlement, and reinforce retaining walls, embankments, and slopes. Geogrids work by distributing loads and confining soil particles. 2. **Geotextiles**:	7	7	7

	• **Description**: Geotextiles are permeable fabrics made of synthetic or natural fibers. • **Function**: They are used for filtration, separation, and reinforcement. Geotextiles can be placed between soil layers to prevent mixing, improve drainage, and enhance soil stability. They are commonly used in road construction and erosion control. 3. **Geocells**: • **Description**: Geocells are three-dimensional honeycomb-like structures made of high-density polyethylene (HDPE) or other materials. • **Function**: They are used to confine and stabilize granular materials like soil or aggregate. Geocells are employed in slope protection, erosion control, and load support applications. 4. **Geomembranes:** **Function**: • Geomembranes are impermeable, thin sheets or membranes made from synthetic materials such as high-density polyethylene (HDPE), polypropylene (PP), or polyvinyl chloride (PVC). • Their primary function is to act as a barrier or liner to prevent the passage of liquids, gases, or contaminants through the underlying soil or substrate. • .			

b)	Reinforced earth is composite material obtained by placing extensible or inextensible materials such as metallic strips or polymeric reinforcement within the soil to obtain the requisite properties. Soil has an inherently low tensile strength but a high compressive strength. An objective of incorporating soil reinforcement is to absorb tensile loads or shear stresses within the structure. In absence of the reinforcement, structure may fail in shear or by excess of the deformation. When an axial load is applied to the reinforced soil, it generates an axial compressive strain and lateral tensile strain. If the reinforcement has an axial tensile stiffness greater than that of the soil, then lateral movements of the soil will only occur if soil can move relative to the reinforcement. Movement of the soil, relative to the reinforcement, will generate shear stresses at the soil/ soil, reinforcement interface, these shear stresses are redistributed back into the soil in the form of internal confining stress. Due to this, the strain within the reinforced soil mass is less than the strain in unreinforced soil for the same amount of stresses.  a) Unreinforced  b) Reinforced	8	8	8

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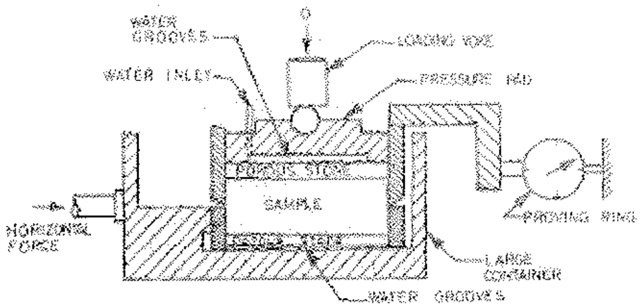
<td>IX</td>
<td>a)</td>
<td>PROCEDURE
1. Check the inner dimension of the soil container.
2. Put the parts of the soil container together.
3. Calculate the volume of the container. Weigh the container.
4. Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil.
5. Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of the soil.
6. Make the surface of the soil plane.
7. Put the upper grating on stone and loading block on top of soil.
8. Measure the thickness of soil specimen.
9. Apply the desired normal load.
10.Remove the shear pin.
11. Attach the dial gauge which measures the change of volume.
12. Record the initial reading of the dial gauge and calibration values.
13. Before proceeding to test check all adjustments to see that there is no connection between two parts except sand/soil.
14. Start the motor. Take the reading of the shear force and record the reading.
15.Take volume change readings till failure.
16. Add 5 kg normal stress 0.5 kg/cm^2 and continue the experiment till failure
17. Record carefully all the readings. Set the dial gauges zero, before starting the experiment

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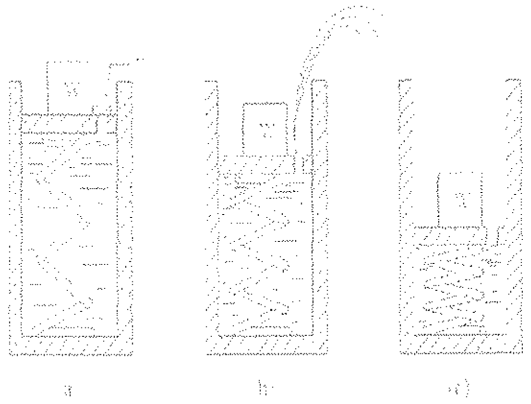
<tr><td>b)</td><td>
Terzaghi's soil-spring analogy model consists of a cylindrical vessel with piston and springs. The space between the springs is filled with water and the pistons are perforated.
The consolidation process in clay subjected to loading is same as behaviour of spring-piston model. The springs surrounded by water represents the soil and water in the vessel represents the water filling the voids in the soil. The compression is one-dimensional and water can drain out only in vertical direction and in the model, flow can take place only upwards.</td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>X a)</td><td>The determination of consolidation properties of soil in a laboratory setting is typically performed using a test called the Consolidation Test or Oedometer Test.Procedure:
1. Sample Preparation:
Trim and prepare the soil sample to the desired dimensions and place it inside the oedometer cell.
Ensure that the soil sample is free of air voids or gaps and is properly saturated with water.
2. Assembly:
Assemble the oedometer cell with the soil sample, porous stones, and dial gauge according to the test apparatus specifications.
3. Initial Loading:
• Apply a small initial load to the soil sample to ensure good contact and eliminate any remaining air voids.
• Record the initial thickness (height) of the soil sample.
4. Saturation:
Place the assembly in a water reservoir or maintain a constant head of water above the soil sample.
5. Consolidation Testing:
Gradually apply incremental loads to the soil sample at specific time intervals.
Measure the settlement (compression) of the soil sample at each load increment using the dial gauge or displacement transducer.
Record the time and corresponding load values.
6. Data Collection:</td><td>7</td><td>7</td><td>7</td></tr>
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	Continue loading the sample until it has undergone sufficient *consolidation, typically until the settlement rate becomes* constant. Record the final thickness of the soil sample. 7. **Calculation:** Calculate the settlement and plot a graph of settlement versus the logarithm of time. From the graph, determine the coefficient of consolidation (cv), which is a measure of the rate at which the soil consolidates.			
b)	**Advantage of direct shear test** • The direct shear test is a simple test and relatively fast especially for granular soils . • The basic principle is easily understood which can be extended to gravelly soils and other materials containing large particles. • The apparatus is relatively cheap. **Disdvantage of Direct Shear Test** • In the test, the failure plane is predetermined (horizontal), and it may not be the weakest one. • The stress distribution along the failure plane is not uniform. • Failure is progressive, and the soil's shear strength is gradually mobilised.	8	8	8