AS-2287
M.Sc. (Third Semester) Examination
(Rural Technology)
RT-903: Soil and Water Conservation Engg.

Section –A
(Objective Type Questions)

(1) Write the correct option:

(i) Which of the following materials has the highest porosity?

d. Sandstones

(ii) What is soil erosion?

b. A process that moves soil by wind and water away from where it is needed

(iii) This type of soil can become as hard as stone when it dries out

a. Clay

(iv) Choose three organisms that live in soil

a. Worms
b. Moles
c. Bacteria

(v) The chemical components produce through biochemical activities of micro-organisms is known as

b. Chelation

(vi) Check dam can be used for?

c. Pisciculture

(vii) This type of dam preferred where the river section is wide and the foundation is unsound

d. Multiple arch dam

(viii) Reduction of moisture in soil is caused by

a. Vegetation

(ix) An animal drawn lifting device capable of lifting water from medium to high depth is

d. Persian wheel

(x) Which water lifting device is called “Simli” in West Bengal?

c. Swing basket

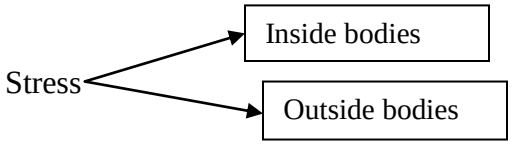
Section – B
(Short Answer Type Questions)

2. **What is Soil mechanics?**

Answer: Soil mechanics is a branch of engineering mechanics that describes the behavior of soils. It differs from fluid mechanics and solid mechanics in the sense that soils consist of a heterogeneous mixture of fluids (usually air and water) and particles (usually clay, silt, sand, and gravel) but soil may also contain organic solids, liquids, and gasses and other matter. Along with rock mechanics, soil mechanics provides the theoretical basis for analysis in geotechnical engineering. It is a sub discipline of civil engineering and engineering geology. Soil mechanics is used to analyze the deformations and flow of fluids within natural and man-made structures that are supported on or made of soil, or structures that are buried in soils. For example building and bridge foundations, retaining walls, dams, and buried pipeline systems. Principles of soil mechanics are also used in related disciplines such as engineering geology, geophysical engineering, coastal engineering, agricultural engineering, hydrology and soil physics.

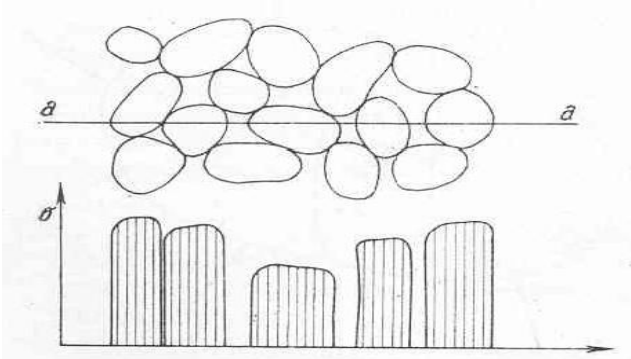
3. **What is meant by Stress in Soil?**

Answer: Stress acts in soil as a result of an external load and the volumetric weight of the material itself. Soils however have a number of properties to distinguish it from other material:



1. Soil can only transfer compressing normal stress and no tensile stress (pressure).

2. Shear stress can only be transmitted if they are relatively small compare to the normal stress.



Furthermore, it is characteristics of soil that part of the stress is transferred by the water in the pores because the normal stress in soil usually is compressive stress only. It is a standard practice to use a sign convention for the stress that a just opposite to the sign convention of classical, continuum machine namely such that compressive stress is considered positive and tensile stress are negative. A stress component is positive when it 'X' in +ve co-ordinate direction on a plain with its outward normal in positive direction. That means the sign of all stress component is just opposite to the sign that they would have in most applied machines.

4. **Write short notes in any two of the following:**

a. Soil atmosphere: The atmosphere of soil is radically different from the atmosphere above. The consumption of oxygen, by microbes and plant roots and their release of carbon dioxide, decrease oxygen and increase carbon dioxide concentration. Atmospheric CO_2 concentration is 0.03%, but in the soil pore space it may range from 10 to 100 times that level. At extreme levels CO_2 is toxic. In addition, the soil voids are saturated with water vapour. Adequate porosity is necessary not just to allow the penetration of water but also to allow gases to diffuse in and out. Movement of gases is by diffusion from high concentrations to lower. Oxygen diffuses in and is consumed and excess levels of carbon dioxide, diffuse out with other gases as well as water. Soil texture and structure strongly affect soil porosity and gas diffusion. Platy and compacted soils impede gas flow, and a deficiency of oxygen may encourage anaerobic bacteria to reduce nitrate to the gases N_2, N_2O, and NO, which are then lost to the atmosphere. Aerated soil is also a net sink of methane CH_4 but a net producer of greenhouse gases when soils are depleted of oxygen and subject to elevated temperatures.

b. **Water:** It is a chemical compound with the chemical formula H_2O. A water molecule contains one oxygen and two hydrogen atoms connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on Earth with its solid state, ice, and gaseous state, steam (water vapor). Water also exists in a liquid crystal state near hydrophilic surfaces. Water covers 71% of the Earth's surface, and is vital for all known forms of life. On Earth, 96.5% of the planet's water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation. Only 2.5% of the Earth's water is freshwater and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained

within biological bodies and manufactured products. Water on Earth moves continually through the water cycle of evaporation and transpiration (evapo-transpiration), condensation, precipitation and runoff usually reaching the sea. Evaporation and transpiration contribute to the precipitation over land.

c. **Natural resources:** It occurs naturally within environments that exist relatively undisturbed by humanity, in a natural form. A natural resource is often characterized by amounts of biodiversity and geodiversity existent in various ecosystems. Natural resources are derived from the environment. Some of them are essential for our survival while most are used for satisfying our wants. Natural resources may be further classified in different ways. Natural resources are materials and components (something that can be used) that can be found within the environment. Every man-made product is composed of natural resources (at its fundamental level). A natural resource may exist as a separate entity such as fresh water, and air, as well as a living organism such as a fish, or it may exist in an alternate form which must be processed to obtain the resource such as metal ores, oil, and most forms of energy. Some natural resources such as sunlight and air can be found everywhere, and are known as ubiquitous resources. However, most resources only occur in small sporadic areas, and are referred to as localized resources. There are very few resources that are considered inexhaustible (will not run out in foreseeable future) – these are solar radiation, geothermal energy, and air (though access to clean air may not be). The vast majority of resources are exhaustible, which means they have a finite quantity, and can be depleted if managed improperly.

d. **Void ratio:** The void ratio of a soil is the volume of soil not occupied by solid particles. The greater the void ratio the looser the soil is. Increasing the void ratio of the soil is done by plowing. Organisms such as worms and ants create a significant amount of the void space in a soil. The higher the void ratio of a soil the more easily water can absorb into it. Soil with a high void ratio is easy for plants to grow in. It is measure of the void volume.

$$e=Vv/Vs$$

Here, e = Void ratio
Vv=Volume of Void (Air + Water)
Vs= Volume of Solid

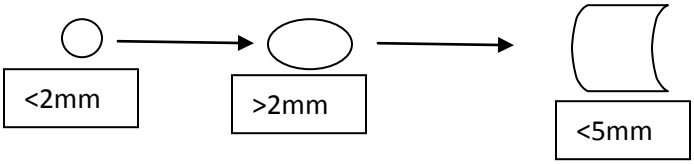
5. **Why water-cycle is important in nature?**

Ans: The water cycle, also known as the hydrologic cycle or the H_2O cycle, describes the continuous movement of water on, above and below the surface of the Earth. The mass water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow. In so doing, the water goes through different phases: liquid, solid (ice) and gas (vapor).

The water cycle involves the exchange of energy, which leads to temperature changes. For instance, when water evaporates, it takes up energy from its surroundings and cools the environment. When it condenses, it releases energy and warms the environment. These heat exchanges influence climate. The evaporative phase of the cycle purifies water which then replenishes the land with freshwater. The flow of liquid water and ice transports minerals across the globe. It is also involved in reshaping the geological features of the Earth, through processes including erosion and sedimentation. The water cycle is also essential for the maintenance of most life and ecosystems on the planet.

6. **Write about the various sizes of rain drops?**

Ans: The rain drops have sizes ranging from 0.1 to 9.0 mm (0.0039-0.35 inches) mean diameter above which due to break up. Smaller drops are called cloud-droplets and their shape is spherical (0<2mm). As a rain drop increases inside its shape becomes more oblate with its target cross section facing the incoming air flow. Large rain drops become increasingly latent on the bottom and its look like Para shoot.



7. **How Aqueduct is important in drainage work?**

Ans: Aqueduct is commonly applied to large channels that carry the main water-supplies. The water may be carried above or below the ground either as a free flowing string or under pressure in a pipe line. It has constructed to convey water. Water often has to be transported from its source such as a lake or river to where it is needed for drinking or irrigation or for other purpose.

Section – C 10x02=20

(Long Answer Type Questions)

Note: Attempt any two questions. Each question carries 10 marks)

8. **Calculate the porosity of a soil sample that has a bulk density of 1.35 gm/cm^3. Assume the particle density is 2.65 gm/cm^3?**

Ans: **Here,**

Bulk density = **1.35 gm/cm^3**

Particle density = 2.65 gm/cm^3

$$\text{Porosity} = \left(1 - p_b/p_p\right) \times 100$$

$$\eta = \left(1\text{-}1.35/2.65\right) \times 100$$

$$= \left(2.65\text{-}1.35/2.65\right) \times 100$$

$$= \left(1.30/2.65\right) \times 100$$

$$\text{Porosity} = 49.0566\%$$

9. **What are the methods of lifting water? Which type of devices are used for lifting water, discuss.**

Ans: Human civilization started with the introduction of rainfed agriculture. Gradually, man realizes that distribution of rain fall is not uniform and to raise a satisfactory crop. It is necessary to apply water artificially. The water lifting devices had started to use in irrigation purpose. Water lifting devices can broadly be classified as:

(i) Indigenous devices: These devices are manually operated and some are animal power driven. These are:

(a) Swing basket
(b) Doon
(c) Counter Poise Lift
(d) Archemedian screw
(e) Mote
(f) Persian wheel
(g) Chain pump
(h) Wind mill

(ii) Mechanical or modern devices: Power operated modern pumping plants have become essential today for better irrigation in less time period. These are:

(a) Reciprocating pump
(i) Bucket pump
(ii)Deep well hand pump

(b) Centrifugal pumps
(i)volute pump
(ii)diffuser or turbine pump

10. **Discuss Check dam? What are the design criteria and installation procedure has taken for the construction of check dam.**

Ans: A check dam is a small dam which can be either temporary or permanent. These are a type of structure which dams up a small river or Nallah in order to break the flow of water during the Monsoon and allow it to seep into the soil.

Check dams range in size, shape and cost. It is possible to build them out of easily available material. It is even possible to built some of these dams at a very little cost. The most important decision to be taken when building such a dam in its location. This is crucial as the effectiveness of the dam depends on it.

Advantages of check dam

Practice description

Planning consideration in check dams:

(i) Rock check dam
(ii) Log check dam (Brushwood)
(iii)Haybales check dam
(iv)Drop spill way
(v) Chute spill way
(vi)Gabion

Design criteria and installation for check dam: The following limiting factors should be designing check dams:

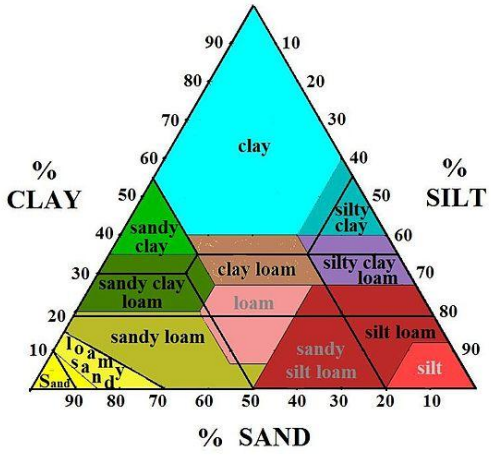
(i) Drainage area
(ii) Maximum height
(iii)Depth of flow
(iv)Side slope
(v) Spacing
(vi)Key way

11. **Give the details about the following:**

a. Soil texture:

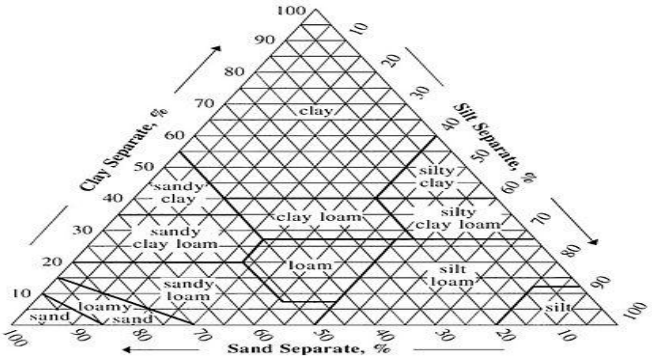
Soil texture is a qualitative classification tool used in both the field and laboratory to determine classes for agricultural soils based on their physical texture. The classes are distinguished in the field by the 'textural feel' which can be further clarified by separating the relative proportions of sand, silt and clay using grading sieves: The Particle-size distribution (PSD).

A soil textural triangle showing the subtle differences between the USDA (colours) and UK- ADAS (black lines) soil classes

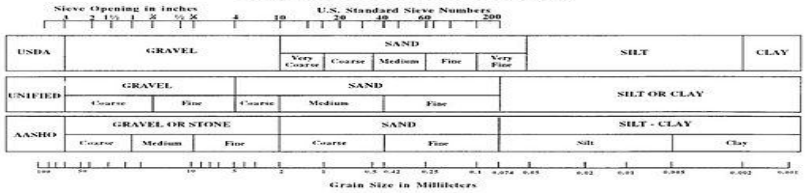


Soil texture classification:

Soil textures are classified by the fractions of each soil separate (sand, silt, and clay) present in a soil. Classifications are typically named for the primary constituent particle size or a combination of the most abundant particles sizes, e.g. "sandy clay" or "silty clay." A fourth term, loam, is used to describe a roughly equal concentration of sand, silt, and clay, and lends to the naming of even more classifications, e.g. "clay loam" or "silt loam." In the United States, twelve major soil texture classifications are defined by the USDA. Determining the soil textures is often aided with the use of a soil texture triangle.'



COMPARISON OF PARTICLE SIZE SCALES



b. Watershed:

Ans: A watershed is an area that drains water and other substances to a common outlet as concentrated drainage. Other common terms for watersheds are drainage basin, catchment or contributing area. The watershed acts as a funnel by collecting all the water within the area covered by the basin and channel in it to a single point. Each watershed is separated topographically from adjacent basin by a geographical barrier such as ridge, hill or mountain.

Classification of watershed:

[A] Based on size:

(i) Micro watershed

(ii) Mini watershed

(iii) Sub watershed

(iv) Watershed

(v) River basin

[B] Based on location:

(i) Runoff watershed

(ii) Recharging watershed

(iii) Storage watershed

[C] Based on ground water exploitation:

(i) Dark watershed

(ii) Grey watershed

(iii) Yellow watershed

[D] Based on shape

(i) square

(ii) Palm

(iii) Triangular

(iv) Polygen

(v) Rectangular

(vi) Circular

(vii) Oval

(viii) Sectoral

(ix) Farm and leaf shaped

For planning and development of any watershed one needs to look deeply into various aspects:

(i) The size, shape and average slope of the watershed

(ii) Vegetation and land use

(iii) Soil texture, depth of soil, geology

(iv) Average annual rainfall, rainfall period and its distribution, rainfall intensity and frequency, infiltration etc.