AS-2971 MODEL ANSWER

# B.Sc (Rural Technology) – 1st semester
# Fundamental of Soil (RT- 107)

**Question 1 Multiple Choice Answer:-**

1. Answer : Acidic

2. Answer : Mechanical weathering

3. Answer : O-horizon

4. Answer : Ammonium to nitrate

5. Answer : Iron and aluminium oxides

6. Answer : Greyish

7. Answer : Time, vegetation and climate

8. Answer : Clay soil

9. Answer : $CaCO_3$

10. Answer : - 15 bars

## Section (B)

Question 2.

A. Explain the bulk density and particle density of soil and its importance in plant growth.

Ans a) **Bulk density**:- It is defined as the mass per unit volume of a dry soil (volume of solid and pore spaces). Expressed in gm/cc. (C.G.S). or lb/cft (F.P.S).

→ The bulk density of a soil is always smaller than its particle density.

→ Loose and porous soil have low weight per unit volume and compact soil have high values.

→ Bulk density of sand dominated soils is about 1.7 gm/cc whereas in organic peat soil the value of bulk density is about 0.5 gm/cc.

→ Bulk density in normal soil ranges from 1.0 – 1.6 gm/cc. (Except in very compact sub soil ie 2 gm/cc

→ Formula:-

$$\text{Bulk density} = \frac{\text{Weight of soil mass}}{\text{Soil volume}}$$

Importance of Bulk density for plant growth.

a) Higher the bulk density, less the pore space and more compacted soil or water logging. This cause decrease in gas exchange. resulting in decreased root growth of plant.

(3).

(b). Soil containing high organic matter show low value of bulk density. This cause better root and plant growth due to better microbial activity of micro-organism.

(c) Low bulk density favour porosity of soil resulting in good aeration and gas exchange.

(b) Particle density :- The weight per unit volume of solid portion of soil is called particle density. It is also termed as true density. It is expressed in gm/cc or lbs/cft.

→ It is depends upon the accumulative densities of the individual inorganic organic constituent of soil.

- Generally in the normal soils the particle density is 2.65 gm/cc.

→ The particle density is higher if large amounts of heavy minerals such as magnetite, limonite, hematite and zircon are present.

→ With increase in organic matter of soil, the particle density decreases.

→ Formula :-

$$\text{Particle density} = \frac{\text{Mass of soil}}{\text{Volume of water displaced by same soil}}$$

⇒ Importance of particle density for plant growth.

a). Increasing the particle density decreases the organic matter content and thus hinder the soil capacity for plant growth.

b) Decomposition of organic matter over tillage operation increase the particle density of soil.

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Question ③ What are the various reason of poor aeration?

Ans:- There are generally two reasons :-

i) Excess moisture :- Due to presence of very high amount of soil moisture with minimum macropores resulting in flooded condition which in turn develops poor soil aeration. This can be prevented by removal of excess water either by drainage or controlled run off.

ii) Gaseous interchange: It depends on 2 factors.

a) The rate of biochemical reactions influencing the soil gases.

b) The actual rate at which each gas is moving into or out of the soil.

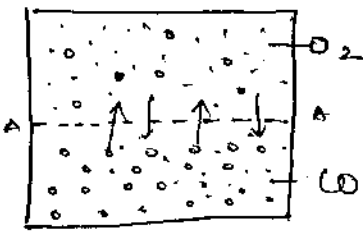
The above exchange of gases is facilitated by two mechanisms.

a) Mass flow: It is due to pressure differences between the atmosphere and the soil air by two ways

i) The contraction and expansion of the air within the pore spaces as well as the tendency for warm air to move upward may cause some exchange between the different layers and with atmosphere.

ii) The difference in temperature between soil and atmosphere also permits exchange between the atmosphere and soil air in the immediate surface.

(b) Diffusion :- It is the molecular transfer of gases. The molecules of gases are in a state of movement in all directions. It is the movement from an area of higher concentration to lower concentration till equilibrium reached.

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Question (4). Explain the importance of soil organism in soil plant growth ?

Ans :- The organism of soil can be classified into following group.

1) Fauna

Macro
- Herbivorous
  - Small mammals
  - Insects
  - Beetles
  - Grubs
  - Millipedes
  - Mites , Slugs & snails and earthworm.
- Predatory
  - Moles
  - Centipedes
  - Spiders

Micro.
- Nematodes
- Protozoa
- Rotifers.

2) Flora.

Macro
- Roots of higher plants
- Algae i) Green
  - ii) Blue-green
  - iii) Diatoms
- Fungi i) Mushroom
  - ii) Yeast
  - iii) Molds

Micro
- Actinomy
- Bacteria
  - Aerob
  - → Anaerob
  - → Autotro
  - → Hetero- tropi

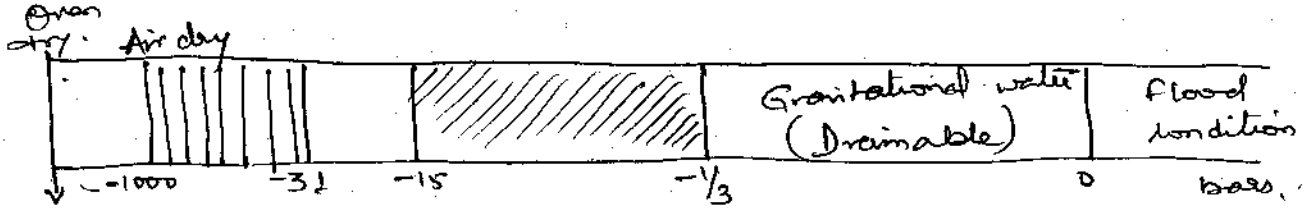
Importance of Soil Organism in relation to plant grow

1). Earthworm increases the soil fertility by degradation of plant residues and helps in soil turning process.
2). Enzymes secreted by earthworm favour mineralizat
3). Earthworm makes the soil granular, porous & fertile f plant growth.
4) Nematodes present in soil takes part in decomposing of organic matter and liberation of nutrients i.e N, P, K etc.

5). Rotifers plays role in breakdown of complex molecules into similar simpler one and helps in release of nutrient.
6). Roots of higher plants acts as storage of suns energy as carbohydrates and thus provide food to several heterotrops.
7) It helps in liberation of various organic acids that dissolves plant nutrient into available form
8). Soil algae fixes atmospheric nitrogen helps in mineralization of nutrients by decomposition of organic matter and synthesis of humus.
9). Actinomycetes helps in decomposition of soil organic matter and liberation of nutrient, producing several antibiotics used for curing of plant diseases.
10). Soil fungus acts as decomposers or saprophytic pathogens or parasitic and symbiotic or mutually beneficial with many plants.
11). Improve soil structure by fungal hyphae bind the soil, creates water stable aggregates and porespace enhancing water retention and drainage.
12). Fungi imparts benefits to plant by increasing nutrients absorption, especially phosphorus, water uptake, tolerance of harsh environmental conditions including polluted environmental situation.
13). It improves growth rate and survival of seedlings
14). Bacteria helps in nitrogen cycle. by inorganic transformation, nitrogen fixation and production of various soil enzymes.

Question (5) Give the physical classification of soil water.

Ans:-




Hygroscopic water
Capillary water.

(Water remaining in soil pores after wetting and drainage)

Under physical classification of soil water, it is grouped into three on the basis of retention:

1) Gravitational Water 2) Capillary water 3) Hygroscopic water

i) Gravitational water: It may be defined as the water that is held at a potential greater than -1/3 bar and that portion of the soil water that will drain freely from the soil by the force of gravity. Inspite of having low energy of retention, gravitational water is of little use to plants water occupies the larger pores resulting poor aeration. Therefore, the removal of excess water is a must for growth of most plants.

ii) Capillary water: It is held in the micro pores of soil. It is retained on the soil particles by force of attraction between soil particles and water molecule Capillary water is held so rigidly that the force of gravity is not able to separate it from the soil particles. It may be defined as the water that is retained in the soil between the water potential of -1/3 bar to -31 bars. The force of retention of water molecules by the soil particle is high and part of wat

is available and part of it is unavailable and so all capillary water is not available to plants. It is related to soil Texture and organic matter, mainly responsible for retention of soil.

(iii) Hygroscopic water (HW):- It is defined as the water that is held by the soil particles at a suction of more than -31 bars. It is essentially non-liquid and moves primarily in the vapour form. This water is held so tenaciously that plants are not able to absorb it and thereby unavailable to plants. It is non liquid and biologically inactive. It is mostly in the form water vapour.

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Question No:- (6). Explain the types of soil survey and its use.

Answer:- Soil survey can be defined as essentially a study and mapping of soil in their natural environment

Types of soil survey:-

1). Detailed survey:- This type of survey is done where soil have maximum use. In this we have conducted soil survey to furnish information required for a proper assessment of soil properties terrain features, erosional aspects and other related factors that can help in working out the use capability and the management practice for soil conservation and better production of crops and maintenance of soil fertility. Cadastral maps (1:8000 or 1:4000 scale) or aerial photographs (1:15000) are generally used as base material for soil maps.

ii) Reconnaissance Soil Survey:- This type of soil survey is undertaken to prepare resource. It identifies broadly the kinds of soils and their extent of distribution. It enables to assess broad potentialities of soils and recognition of areas of promise that are suitable for intensive and modern agriculture and those requiring priority for amelioration. In these surveys the soil boundries are not totally traversed but drawn partly by extrapolation. The scale of mapping is 1:50000.

iii). Detailed-Reconnaissance Soil Survey :- It is a combination of reconnaissance and detailed soil surveys and is undertaken for understanding distribution of basic soil classes of series and their phases.

iv). Semi-Detailed Soil Survey :- This kind of soil survey comprises very detailed study of some selected strips cutting across many aerial-photo interpretation units for developing correlation between API and soils. This type of soil survey provide adequate information about various kinds of soil, including problematic soils.

Recently three are 2 other types of soil survey have been recognized ie Exploratory and Rapid reconnaissance soil survey. These lead to the preparation of small scale soil maps that are needed for macro-level planning for diversified agro-based development-programmes. They are necessary to plan develop and apply effectively drainage and irrigation practices on

from lands.

Question (8) Explain the metamorphic rock with properties and suitable examples.

Answer:- Metamorphic rocks may be defined as those which have undergone some chemical or physical change from its original form. They are formed from the subsequent transformation of igneous and sedimentary rocks under the influence of chemically active liquids and gases and internal heat and pressure. The structure and mineral composition of metamorphic rocks depend on the constituents of the original rocks and the kind of metamorphism.

Properties:-

1). formation takes place due to metamorphism
2). Main factor for formation is water, temperature and pressure.
3). It is of foliated and non-foliated types
4). It sometimes crystalline as igneous rocks.
5). Metamorphic rocks on degradation leads to formation of various types of soil.
6). It is very hardy in nature.

Some examples includes:-

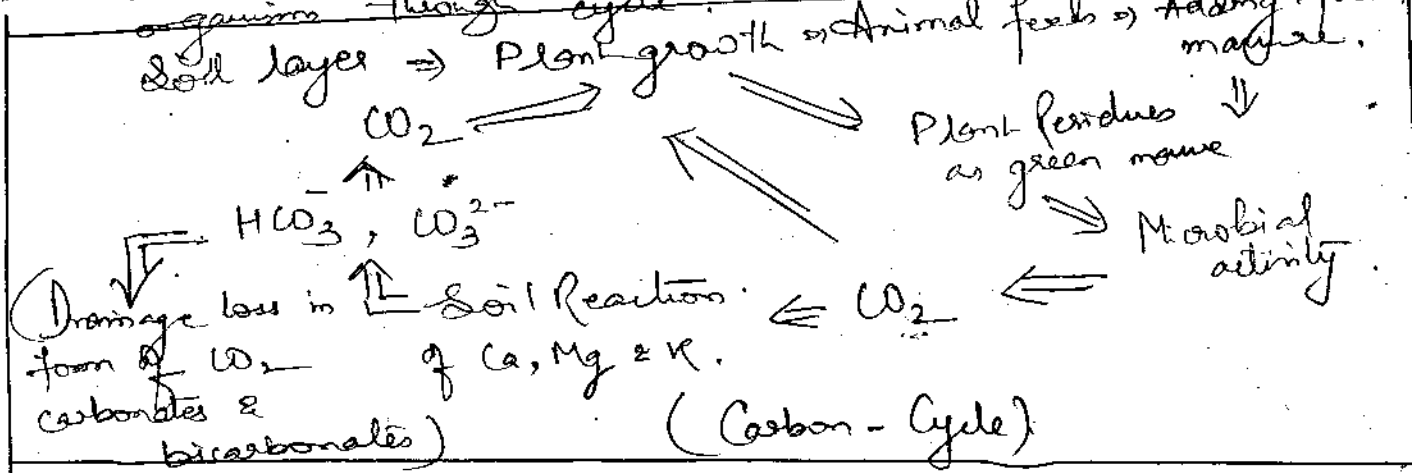
1). Gneiss - Light coloured (Granites origin)
2). Schist - Fissile or foliated.
3). Quartzite - $SiO_2$ Recrystallized sandstone by action of heat and pressure
4) Slate:- Hardened shale or siltstone or mudstones containing fine grained rocks high in mica & quartz
5) Marble - of Limestone ($CaCO_3$) or Dolomite hardened enough to polish.

## Section C : Long question answer.

Ans 8. (a) **Soil algae:** Algae that live on the surface of or in soil. About 2000 species of microscopic soil algae are known, mainly Blue, Yellow green and diatoms algae. Developing mostly in the upper soil horizons; they synthesize organic matter and help to improve the soil structure. They are:-

i) Having chlorophyll capable for photosynthesis
ii) Present on surface of soil (exception on subsoil as spores and cyst of algae).
iii) It contributes to organic matter of soil.
iv) It fix atmospheric nitrogen
v) It helps in decomposition and mineralisation of nutrients.

(b) **Carbon cycle:-** Carbon is a common constituent of all organic matter. It is being continuously fixed into organic form by photosynthesis organisms under the influence of light and once bound, the carbon becomes unavailable for use in the generation of new plant life. Therefore, it is essential for carbonaceous materials to be decomposed to and returned to the atmosphere for survival of higher organisms through cycle.




(Carbon - Cycle)

(c) Oxygen diffusion rate (O.D.R) :- It is one of the criteria generally used to determine the $O_2$ concentration in the soil pore space. It consist of allowing the free diffusion of $O_2$ into a diffusion chamber that was inserted into the soil. The calculated partial pressure of $O_2$ at 10 minute interval was used to evaluate the diffusion rate.

Thus O.D.R. is the rate at which $O_2$ can be replenished if it is used by respiring plant roots or replaced by water. The O.D.R. characterises the soil $O_2$ conditions. It has been found that the roots growth ceased when O.D.R. dropped to about 20 gm $\times 10^{-8}$ / $cm^2$ / min.

(d) Organic matter :- The soil organic matter consists of a whole series of products which range from undecomposed plant and animal tissues to fairly amorphous brown to black material bearing no trace of anatomical structure of the material.

Effect of organic matter in soil.

→ Helps in granulation of soil, better aeration, Plasticity & Cohesion properties of soil are reduced.
→ Increase W.H.C of soil and prevents soil erosion.
→ Act as powerhouse of various nutrients as well as increase the buffering capacity of soil.
→ Provides food and energy for micro-organisms.
→ Enhance microbial activities and soil fertility.

© Laterization :- Laterite in latin mean- brick like. In this situation the A horizon of soil profile becomes red due presence of ferric oxide (Haematite) as major, called laterite soil and process is termed as Laterization.

Situation mainly occurs in tropic and sub-tropic region of high temperature and heavy rainfall continuously. In this there is leaching loss of organic material into lower horizon causing red to violet colouration of soil. Fertility is low with acidic nature.

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(9) Answer :- Soil :- Definition.

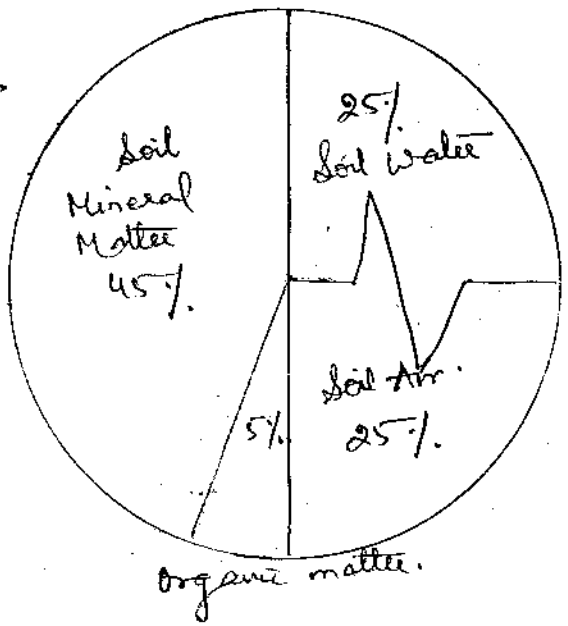
(a) According to Buckmann and Brady, "Soil may be defined as, "A dynamic natural body on the surface of the earth in which plants grow, composed of mineral and organic materials and living forms."

(b) Acc to Raman - "The upper weathering layer of the solid earth crust" is called soil.

Components of Soil :-

→ It consist of 4 major components

i) Mineral Matter ≃ 45 %.
ii) Organic matter ≃ 5 %.
iii) Soil Air ≃ 25 %.
iv) Soil water ≃ 25 %.



(a) Mineral matter of soil:- The size and composition of mineral matter are variable due to nature of parent rock of origin. It is generally composed of very fine broken rock fragments and minerals either dominated by inorganic constituents or dominated by distinct minerals like quartz and feldspars. The rock fragments are disintegrated and broken portions of the massive rocks from which the regolith through weathering the soil have been formed. It is about 45 %.

In generally, the primary mineral dominate the coarsed fraction of soil. on the other hand, the secondary mineral ie silicate clay and hydrous oxide clay of iron and aluminum are present as very finer fraction clay in the soils.

(b) Organic matter in soil:- It exists as partly decayed and partially synthesized plant and animal residues. The organic matter content in a soil is very small and varies from 3 to 5 % by weight in a top soil. It acts as a store house of nutrients in soil. Organic matter act as a chelate that bound to a metal by more than one bond and form a ring or cyclic structure by that bonding and thus increases mobility of metallic elements in soil. It reduces soil erosion shades the soil and keep the soil cooler in very hot weather and warmer in winter.

© Soil Water :→ It plays a very significant role in soil plant growth relationship. The movement and retention of water in soil is influenced by characteristics of soil ie texture, structure, nature of inorganic and organic colloids, type and amount of exchangeable cations and size and total amount of pore spaces. Soil water presents along with dissolved salts and makes up the soil solution. This soil solution acts as an important medium for supplying different essential nutrient elements to growing plants. It is near about 25 % in soil normally.

(d) Soil Air :— It contains various gases like $O_2$, very small amount of $O_2$ and $N_2$ etc. Soil air differs from atmospheric air. Generally soil air contains much more $CO_2$ and small amounts of $O_2$ than that of atmospheric air due to microbial respiration where large amounts of $CO_2$ releases into the soil and the oxygen is taken up by the soil micro-organisms. Good aeration can occur in well drained soils which have sufficient proportion of their volume occupied by pores. It is near about 25 % normally.

Volumetric Composition of Soil Air (%)

| | $O_2$ | $CO_2$ | $N_2$ |
|---|---|---|---|
| Soil Air | 20.60 | 0.25 | 79.2 |
| Atmospheric Air | 20.96 | 0.03 | 79.0. |

Answer (19) :- Classification of minerals are on the base of following points.

i) According to genesis / origin :- It is of 2 types

(a) Primary / original minerals :- It is inherited from the parent rocks after the cooling and solidification of molten matter. Examples :- Feldspar (Orthoclase), Quartz ($SiO_2$), Mica, Dolomite and Gypsum.

(b) Secondary minerals :- It is formed by low temperature reaction and inherited by soils from sedimentary rocks or formed in by weathering. Particle size is smaller than primary mineral particle. Examples : Iron pyrites, Magnetite, Apatite Kaolinite. Illite and Montmorillonite.

ii) According to chemical composition :- On the basis elements and compounds present in the minerals. It includes :-

a) Silicate group - Kaolinite, Montmorillonite, Illite, Muscovite
b) Oxide group - Quartz, Haematite, Magnetite, Rutile.
c) Carbonate group - Calcite, Dolomite,
d) Halides group - Rocksalt
e) Sulphate group - Gypsum.
f) Sulphide group - Pyrite ($FeS_2$)
g) Phosphate group - Florecapetite.

iii) According to the amount :- It includes two group.

a) Essential mineral :- It includes major parts of rocks and present in quantities varies from 95-98 % example - Feldspar, Quartz, Mica etc.

(b) Accessory mineral :- In this variety of mineral occurs in very small but significant quantities i.e. 2-5%.. examples : Pyrite, Calcite, Apetite etc.

iv). <u>According to specific gravity</u> :- It includes two groups.

a) Heavy mineral :- Specific gravity of this heavy mineral is more than 2.85. Examples :- Haematite (5.3), Pyrite (5.0), Limonite (3.8). etc

b) Light mineral :- Specific gravity of this mineral is less than 2.85. Examples :- feldspar (2.65), Quartz (26), Muscovite (2.5 - 2.75) etc.

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(11) Answer :- The various chemical agents of weathering are :- Presence of moisture cause chemical reaction on rocks leading to chemical weathering.

i) <u>Oxidation</u> :- Addition of $O_2$ and removal of $H_2$ or electron cause oxidation

Examples :- i) $4FeO + O_2 \longrightarrow 2Fe_2O_3$.

ii) $FeS + 2O_2 \longrightarrow FeSO_4$

iii) $4FeCO_3 + O_2 \longrightarrow 2Fe_2O_3 + 4CO_2$.

ii) <u>Reduction</u> :- Removal of $O_2$ and addition of $H_2$ and electron is termed as reduction. It mainly occurs at an area of heavy moisture zone causing deduction of air and reduction of $O_2$

Examples :- $2Fe_2O_3 \longrightarrow 4FeO + O_2$

$4CuO \longrightarrow 2Cu_2O + O_2$

iii). Hydration :- Addition of water molecules to the compounds is termed hydration. It cause increase in volume but after dehydration it shrink. This process cause adverse effect on rock. Examples :- $2Fe_2O_3 + 3H_2O \rightarrow 2Fe_2O_3.3H_2O$.
$CaSO_4 + 2H_2O \rightarrow CaSO_4.2H_2O$.

iv) Hydrolysis :- Breakdown of the main compound group into its constituent after addition with water molecules. In this water molecules breaks into $H^+$ and $OH^-$ along with chemicals of rocks.
Examples :- 1) $KAlSi_3O_8 + H_2O \rightarrow HAlSi_3O_8 + KOH$
2) $CaSiO_3 + 2H_2O \rightarrow H_2SiO_3 + Ca(OH)_2$.
High temperature and acid cause increase in proces

v) Dehydration :- The process is opposite to hydration ie removal of water molecules from the compound of mineral matter
Examples :- 1) $2Fe_2O_3.3H_2O \longrightarrow 4FeO + O_2 + 3H_2O$.
2) $CaSO_4.2H_2O \longrightarrow CaSO_4 + 2H_2O$.

vi) Carbonation :- It is the process of formation of $CO_3^{2-}$ and $HCO_3^-$ by $CO_2$ on the rocks.
Examples :- 1) $H_2O + CO_2 \longrightarrow HCO_3$ (Carbonic Acid)

vii) Decarbonation :- This process cause removal of $CO_2$ compound from the rocks leading to proces of decarbonation. Eg:- $Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + 2H_2O$.