AV-9012

Department of Rural Technology and Social Development, GGU, Bilaspur (C.G.)

Odd Semester Examination 2015-16: B.Sc. (Hon's) Ist Semester

RT 101: Fundamentals of Soil

Time: 3 hours **Max. Marks: 30**

Section - A

Q. 1. Objective Type Questions (01 Mark each) **10 Marks**

(i) The bacteria requires optimum temperature between 15^{o}C- 45^{o}C for their growth and development are known as_____.
b. Mesophile

(ii) Soil air contains _____times more carbon dioxide than the atmospheric air.
b. 5-10

(iii) _____indicates the lightness or darkness of the dominant spectral colour.
a. Value

(iv) Redish colours of soil are characteristics of well _____ conditions.
b. Oxidized

(v) _____ means two microorganisms behave entirely independently.
c. Neutralism

(vi) _____is the accumulation of sodium ions on the exchange complex of the clay, resulting in the formation of sodic soils.
a. Alkalization

(vii) _____ is the process of transformation of unconsolidated sediments to hard rock.
a. Diagenesis

(viii) _____ referred to mineral weathering is both the chemical combination of oxygen with a compound and the loss of electron of some chemical element.
b. Oxidation

(ix) _____soils in which development of normal profile under the influence of climate and vegetation.
b. Ectodynamomorphic

(x) _____ metamorphism in which the formation of rocks bring about by the combined effect of pressure and heat.
b. Dynamothermal

Section – B

Short Answer Type Questions (Attempt any four): **2.5×04 = 10 Marks**

Q. 2. Differentiate between surface soil and sub surface soil.

Surface soil	Sub-soil
1. It is completely weathered.	1. It is partially weathered.
2. Surface soil is dominated by finer particles like silicate clays.	2. Sub-soil is dominated by quartz particles and other course fragments of minerals.
3. Surface soil is porous and friable.	3. The sub-soil is more massive and compact.
4. Aeration status of surface soil is good and exchange of gases between atmosphere and soil air takes place.	4. Aeration status of sub-soil is very poor and hence exchange of gases is very much limited.
5. The number and activity of soil micro-organisms is very high.	5. The microbial population and their activity is very low.
6. Relatively higher organic matter content due to presence of higher biomass on the soil surface.	6. Due to lack in plant and animal residues in the sub-soil, the amount of organic matter is very low.

7. Due to presence of high organic matter content the colour of surface soil is deep brown or dark. 8. It is fertile. Most of the essential plant nutrients are present. 9. Surface soil has no hard pan. 10. It has good physical management condition because of surface soil. 11. Cation exchange capacity is very high.	7. The colour of sub-soil is light and sometimes may be light yellowish colour depending on the nature and kinds of unweathered materials. 8. It is less fertile, very few essential plant nutrients are present. 9. Sub-soil sometimes has hard pan. 10. It has poor physical condition. 11. Cation exchange capacity is low.

Q. 3. Give the classification of different weathering agents.
Classification of different agents of weathering agents as below:

Physical/ Mechanical (disintegration)	**Chemical (decomposition)**	**Biological (disintegration + decomposition)**
1.Physical condition of rock	1.Hydration	1.Man & animals
2.Change in temperature	2.Hydrolysis	2. higher plants & their roots
3.Action of H_2O	3.Solution	3.Micro organisms
-fragment & transport	4.Carbonation	
- action of freezing	5.Oxidation & Reduction	
- alternate wetting & drying		
- action of glaciers		
4.Action of wind		
5.Atmospheric electric phenomenon		

Q. 4. Short note (both compulsory)

i. Gravimetric method of soil moisture determination

This method is the classical procedure used as the check for all other methods. A soil is sampled, put into a container, weighed in the sampled (moist condition), oven dried, and weighted again after drying. Drying is done at 105˚C-110˚C (221-230˚F) to constant weight (2 hrs) for small samples, but as much as days for bulky clayey soil samples and low airflow in the oven. The mass water content is the decimal value that equals the weight of water divided by the weight of oven dried soil. The mass water percentage (P_m) is calculated on the basis of dry soil weight using the following formula:

$$\% \text{ moisture} = \frac{weight\ of\ moist\ or\ wet\ soil - weight\ of\ oven\ dry\ soil}{weight\ of\ oven\ dry\ soil} \times 100$$

Advantages of gravimetric method

- It is the most accurate of all methods presently in use.
- The results are not affected by the presence of salts in the soil sample.
- No. complicated equipments is required and the procedure is very simple.

Limitations

This method, however suffers from several limitations. It is laborious and time consuming as it involves sampling from the field, transporting, drying, and repeated weighing. The sampling may cause considerable error depending upon the field variability. The water content values for stony soil or gravelly soil can be misleading as rock fragment contribute on to mass and volume and not to pore space.

ii. Relationship Between Porosity and Densities of soil

$$\% \text{ solid space } = \frac{bulk\ density}{particle\ density} \times 100$$

Since,

$$\% \, pore \ space + \% \, solid \ space = 100$$

or,

$$\% \, pore \ space = 100 - \% \, solid \ space$$

or,

$$\% \, pore \ space = 100 - \frac{bulk\ density}{particle\ density} \times 100$$

$$\% \, pore \ space = 100 \, [1 - \frac{bulk\ density}{particle\ density}]$$

Q. 5. Explain the importance of soil organisms.

Importance of Soil organisms

- Soil organisms are responsible for many of chemical transformations in soil. The microbes which utilizes carbonaceous materials for their energy, transform organic nitrogen, phosphorus and sulfur compounds into organic compounds, which are utilized by higher plants.
- Many mineral nutrients including micronutrients held in an available organic combination are also released in an available form by microbial decomposition.
- The bulks of soil bacteria are heterotrophic and utilize readily available source of organic energy from sugar, starch, cellulose and protein.
- The number of actinomycetes may be as high as 200 million per gm of soil and may increase in manured soil. Actinomycetes grow on complex substance such as keratin, chitin and other complex polysaccharides and thus they play an active role in humus formation.
- Soil fungi are mostly heterotrophs and use organic residues easily but their number vary in soil depending on whether a species has a dominant vegetative or reproductive phase in the environment.
- The addition of sulfur to alkali soils is beneficial because of the activity of sulfur oxidizing bacteria, which produces sulfuric acid.
- The role of nitrogen fixing organisms in recuperation of nitrogen reserves in soil has been established. Both symbiotic and non-symbiotic organisms are responsible for maintain the nitrogen in soil.
- Phosphate solublizing bacteria help in maintaining the available forms of phosphate because the available forms of phosphate because phosphobateria is likely to succeed in areas where available phosphorus is low.
- Wormcasts from earthworms is an important medium for multiplication of microorganisms.

Q. 6. Give the classification of soil separates according to USDA and ISSS.

Classification of soil separates according to USDA

	Soil separates	Diameter (mm)
1.	Clay	<0.002
2.	Silt	0.002- 0.05
3.	Very Fine Sand	0.05- 0.10

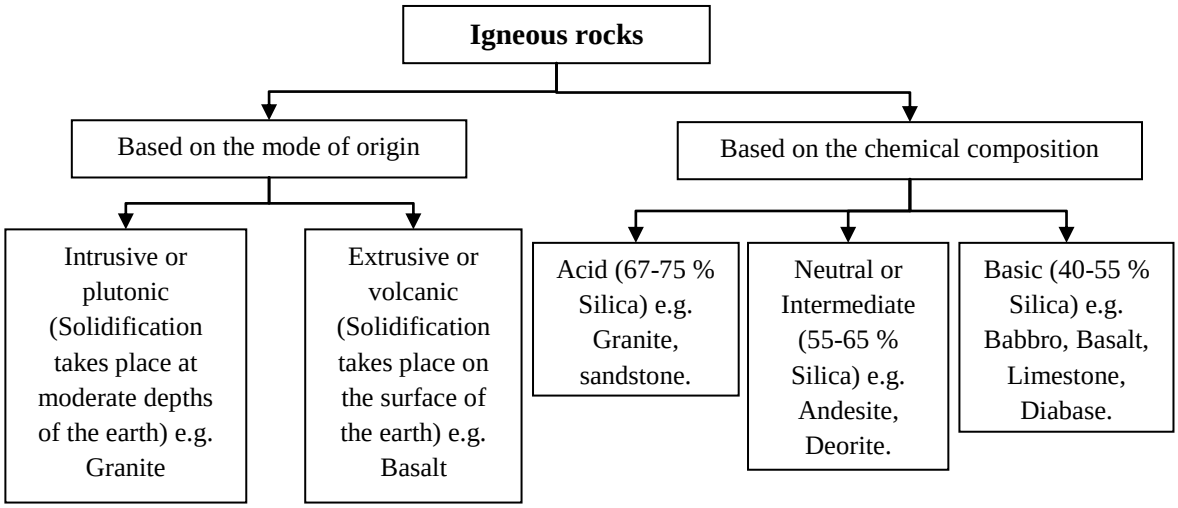
4.	Fine Sand	0.10- 0.25
5.	Medium Sand	0.25- 0.50
6.	Course Sand	0.50- 1.00
7.	Very Course Sand	1.00- 2.00

Classification of soil separates according to USDA

	Soil separates	Diameter (mm)
1.	Clay	< 0.002
2.	Silt	0.002- 0.02
3.	Fine Sand	0.02-0.2
4.	Course sand	0.2-2.0

Q. 7. Write note on 'Igneous rocks'.

Igneous rocks: They are formed by solidification of molten material magma on or beneath the surface of the earth. They are characterized by non-laminar massive structure and on whole, make up 95% of the earth's crust. During volcanic eruptions, which are brought about by increased pressure of the earth due to some geological changes, molten mass or lava is forced out to the surface of the earth.



Section-C

Long Answer Type Questions (Attempt any two): 5×02 = 10 Marks

Q. 8. Define soil survey, enlist and explain various types of soil survey.

Soil survey: Soil survey is a definite study of soil morphology in the field, corroboration of diagnostic soil properties in the laboratory, classification of soils of the area in well defined units, plotting their extent and boundaries on a map, and prediction of the adaptability of these soils to various uses.

Types of soil survey

i. Detailed soil survey
ii. Reconnaissance soil survey
iii. Detailed- reconnaissance soil survey
iv. Semi-detailed soil survey

i. Detailed soil survey:

In detailed soil survey boundaries of soil units are delineated from observations by actual traverses throughout the course of the boundary. Soils are examined in detail and the close intervals in an area to detect differences that can be significant in their use and management. Detailed soil surveys are conducted 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 practices for soil conservation and better production of crops and maintenance of soil fertility. Cadastral maps (1: 8000 or 1: 4000 scale) for detailed soil survey. The mapping units on a detailed soil map show soil series, type and phase. Detailed soil surveys are laborious, time consuming and much expensive. Detailed soil survey is of two types, i.e. low and high intensity survey.

ii. Reconnaissance soil survey

This type of soil survey is undertaken to prepare resource inventory of large areas. It identifies broadly the kinds of soil and their extent of distribution. It enables to assess broad potentialities of soils and recognition of the areas of promise that are suitable for intensive and modern agriculture and those requiring priority for amelioration. In these surveys the soil boundaries are not totally traversed, but drawn partly by extrapolation. The scale of mapping is 1: 50000 using topographical maps of the survey of India as base material or aerial photographs of similar scale wherever available. Reconnaissance soil surveys give information for detailed soil surveys and broad land use planning and agriculture development.

iii. Detailed- Reconnaissance soil survey

It is a combination of Reconnaissance and detailed soil surveys and is taken for understanding distribution of basic soil classes of series and there 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 (API) units for developing correlation between API units and soils. This type of soil survey provides adequate information about various kinds of soils, including problematic soils. Recently there are two other types of soil survey have been recognized i.e. 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.

Q. 9. What is the relation between soil air and plant growth?

Soil air in relation to plant growth:

Concentration of CO_2 in soil air in excess of 1% causes toxicity to most crop plants. Thus relative concentrations of CO_2 and oxygen in soil air is of significance from the point of view of most crops. This is summarized below:

a. Availability of water and nutrients: When oxygen is less in soil, plant roots are unable to extract more water and nutrients. Even under waterlogging conditions, plant may suffer shortage of water and nutrients, which they could not absorb due to lack of oxygen.

b. Oxygen Diffusion Rate (ODR): Oxygen diffusion rate (The rate at which oxygen in the soil exchange with oxygen in the atmosphere), indicates the rate at which oxygen can be replenished when it is used by plant roots or by soil micro-organisms.

c. Effect of redox potential: Oxidation reduction potential (Eh); provides a measure of the tendency of a system to reduce or oxidize elements. It is measured in volts or millivolts. If Eh is positive, strong oxidizing conditions exist. If Eh id negative, elements are found in reduced

forms, which are toxic to plants. Soil air has an important role in oxidation reduction reaction of iron and manganese.

d. Soil aggregation: The failure of poorly aggregated soils to respond to fertilization may be because of deficient oxygen supply and low nutrients absorption.

e. Microbial activity:
All aerobic organisms need oxygen to function properly. Under poor aeration condition only anaerobic and facultative microorganism can function.

f. Root growth and development:
Aeration requirements for plants differ. Legumes are sensitive to poor aeration whereas grasses are tolerant. Development of roots requires oxygen. The water intake of plant decreases under poor aeration. A difference in the internal structure of roots is observed depending upon the status of aeration.

g. Incidence of disease:
Insufficient soil aeration is associated with the incidence of disease in some crops. Wilt, a very common fungal disease of plants, is due to waterlogging of surface soils.

h. Accumulation of toxic substances:
Poor aeration results in the development of toxins and other injurious substances such as dihydroxysteric acids. It leads to the accumulation of organic acids such as butyric acids, lactic, acetic acid etc. in toxic quantities.

Q. 10. Describe soil profile in detail.
Soil profile:

The vertical section of the soil showing the various layers from the surface to the unaffected parent material is known as a soil profile.

The various layers are known as horizons. A soil profile contains three main horizons. They are named as horizon A, horizon B and horizon C.

i. The surface soil or that layer of soil at the top which is liable to leaching and from which some soil constituents have been removed is known as **horizon A** or **the horizon of eluviation**.
ii. The intermediate layer in which the materials leached from horizon A have been redeposited is known as **horizon B** or **the horizon of illuviation**.
iii. The parent material from which the soil is formed is known as **horizon C**.

A Study of soil profile is important as it is historic record of all the soil forming processes and it forms the basis for the study in pedagogical investigations. Soil profile is the key for the soil classification and also forms the basis for the practical utility of soils. A hypothetical mineral soil profile will include O, A, B, C and R master horizons and all the possible sub-horizons.

Organic or O horizon - It is called as organic horizon. It is formed in the upper part of the mineral soil, dominated by fresh or partly decomposed organic materials. This horizon contains more than 30% organic matter if mineral fraction has more than 50 % clay (or) more than 20 % organic matter if mineral fraction has less clay. The organic horizons are commonly seen in forest areas and generally absent in grassland, cultivated soils.

OL_1 - Organic horizon in which the original forms of the plant and animal residues can be recognized through naked eye.

OL_2 - Organic horizon in which the original plant or animal matter can not be recognized through naked eye.

A horizon (Eluvial)- Horizon of organic matter accumulation adjacent to surface and that has lost clay, iron and aluminium.

A_1 - Top most mineral horizon formed adjacent to the surface. There will be accumulation of humified organic matter associated with mineral fraction and darker in colour than that of lower horizons due to organic matter.

A_2 - Horizon of maximum eluviation of clay, iron and aluminium oxides and organic matter. Loss of these constituents generally results in accumulation of quartz and other sand and silt size resistant minerals. Generally lighter in Colour than horizons above and below.

A_3 - A transitional layer between A and B horizons with more dominated properties of A_1 or A_2 above than the underlying B horizon. This horizon is sometimes absent.

B horizon (Illuvial)- Horizon in which the dominant features are accumulation of clay, iron, aluminium or humus alone or in combination. Coating of sesquioxides will impart darker, stronger of red Colour than overlying or underlying horizons.

B_1 - A transitional layer between A and B. More like A than B.

B_2 - Zone of maximum accumulation of clay, iron and aluminium oxide that may have moved down from upper horizons or may have formed in situ. The organic matter content is generally higher and Colour darker than that of A_2 horizon above.

B_3 - Transitional horizon between B and C and with properties more similar to that of overlying B_2 than underlying C.

C horizon - It is the horizon below the solum (A + B), relatively less affected by soil forming processes. It is outside the zone of major biological activity. It may contain accumulation of carbonates or sulphates, calcium and magnesium.

R - Underlying consolidated bed rock and it may or may not be like the parent rock from which the solum is formed.

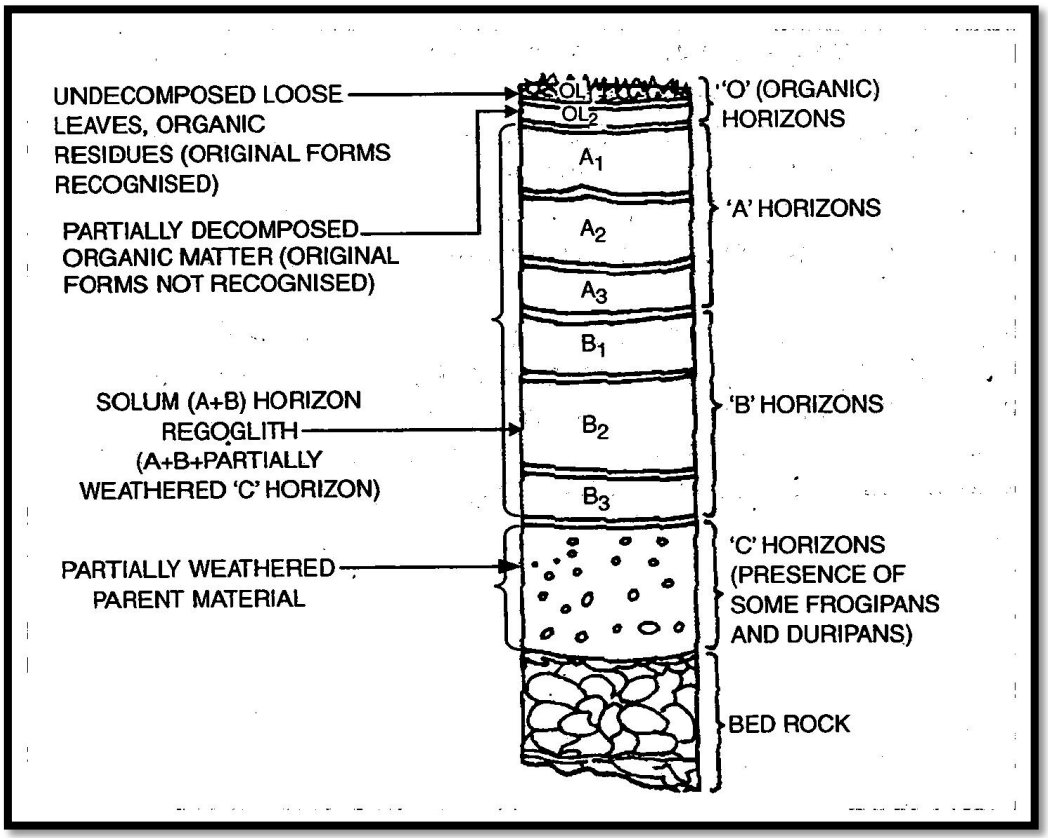


Fig. Soil profile consisting of all horizons

Q. 11. Which factors are responsible for development of structure in arable soil?
The development of structure in arable soil depends on the following factors:

1. Climate
Climate has considerable influence on the degree of aggregation as well as on the type of structure. In arid regions there is very little aggregation of primary particles. In semi arid regions, the degree of aggregation is greater.

2. Organic matter
Organic matter improves the structure of a sandy soil as well as of a clay soil. In case of a sandy soil, the sticky and slimy material produced by the decomposing organic matter and the associated microorganism cement the sand particles together to form aggregates. In case of clayey soil, it modifies the properties of clay by reducing its cohesiveness. This helps making clay more crumby.

3. Tillage
Cultivation implements break down the large clods into smaller fragments and aggregates. For obtaining good granular and crumby structure, optimum moisture content in the soil is necessary. If the moisture content is too high it will form large clods on drying. If it is too low some of the existing aggregates will be broken down.

4. Plants, Roots and Residues
Excretion of gelatinous organic compounds and exudates from roots serve as a link
Root hairs make soil particles to cling together – Grass and cereal roots Vs other roots-
Pressure exerted by the roots also held the particles together.
Dehydration of soil - strains the soil due to shrinkage – result in cracks – lead to aggregation.
Plant tops and residues – shade the soil – prevent it from extreme and sudden temperature and moisture changes and also from rain drop impedance.
Plant residues – serve as a food to microbes – which are the prime aggregate builders.
5. Animals
Among the soil fauna small animals like earthworms, moles and insects etc., that burrow in the soil are the chief agents that take part in the aggregation of finer particles.
6. Microbes
Algae, fungi, actinomycetes and fungi keep the soil particles together. Fungi and actinomycetes exert mechanical binding by mycelia, Cementation by the products of decomposition and materials synthesized by bacteria.

7. Fertilizers
Fertilizer like Sodium Nitrate destroys granulation by reducing the stability of aggregates. Few fertilizers for example, CAN help in development of good structures.

8. Wetting and drying
When a dry soil is wetted, the soil colloids swell on absorbing water. On drying, shrinkage produces strains in the soil mass gives rise to cracks, which break it up into clods and granules of various sizes.
9. Exchangeable cations

Ca, Mg	H, Na
Flocculating	Deflocculating
Good structure	Poor structure

10. Inorganic cements: $CaCO_3$ and Sesquioxides
11. Clay- act as binding agent
12. Water – responsible for various chemical reactions and acting as a physical force