Model Answer Paper

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SEMESTER END THEORY EXAMINATION
B.Sc. (Hons.) Agriculture

Semester	: I (New)	Term	: I	Academic Year	: 2022-23
Course No.	: SSAC-111	Title	: Fundamentals of Soil Science		
Credits	: 3(2+1)				
Day & Date	:	Time (hrs.)	: 3 hrs.	Total Marks	: 80

Note :
1. Solve ANY EIGHT questions from SECTION "A".
2. All questions from SECTION "B" are compulsory.
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

SECTION "A"

Q.1 a) Define soil. Give the approaches of soil study.

Soil – A dynamic natural body on the surface of the earth in which plant grow, composed of mineral and organic minerals and living forms. 4 Marks

Approaches of soil study –

Pedological approach : Origin of the soil, its classification and description are examined in pedology.

Edaphological approach : It is the study of soil from the standpoint of higher plants and study of various properties of soil in relation to plant production.

b) Define Mineral. Classify the general properties of minerals.

A mineral is a naturally occurring homogenous element or inorganic compound that has a definite chemical composition and a characteristic geometric form. 4 Marks

Properties of minerals

1. Colour 2. Lustre 3. Light transmission 4. Hardness 5. Streak 6. Specific gravity 7. Form and structure 8. Cleavage 9. Fracture 10. Tenacity 11. Chemical nature

Q.2 a) Define weathering. Enlist different types of weathering and explain any one of them.

"Weathering is a process of disintegration and decomposition of rocks and minerals which are brought about by physical agents and chemical processes, leading to the formation of regolith (unconsolidated residues of the weathering rock on the earth's surface or above the solid rocks)". 4 Marks

Depending upon the agents taking part in weathering processes, it is classified into three types, viz. Physical, chemical and biological weathering.

A Physical Weathering

1. Physical condition of rocks
2. Action of temperature
3. Action of water □ Action of freezing □ Alternate wetting and drying. □ Action of glaciers 4. Action of wind and sand blast 5. Atmospheric electrical phenomenon.

B. Chemical Weathering
Solution, Hydration, Hydrolysis, Oxidation, Reduction, Carbonation.
C. Biological weathering
Algae and Higher plants and their Micro-organisms

b. Differentiate between bulk density and particle density. 4 Ma

Soil density is expressed in two well accepted concepts as particle density and bulk density. In the metric system, particle density can be expressed in terms of mega grams per cubic meter (Mg/m3).

Particle Density: The weight per unit volume of the solid portion of soil is called particle density. Particle density is also termed as true density.

Bulk Density: The weight per unit volume of soil (including pore space) is called bulk density. Bulk density is dynamic in nature.

a. Enlist different pedogenic processes and explain fundamental pedogenic processes in detail. 4 Marks

There are two pedogenic processes of soil formation
Fundamental Pedogenic
Specific Pedogenic

Fundamental pedogenic processes –

1. Humification – It is the processes of decomposition of organic matter and synthesis of new organic substance.
2. Eluviation – It is the mobilization and translocation of certain constituents from one point of soil to another.
3. Illuviation – The processes of deposition of soil materials in the lower layer.
4. Horizonation- it is the processes of differentiation of soil in to different horizons.

b. Explain soil forming factors? Enlist passive soil forming factors in detail. 4 Marks

Soil Forming Factors Jenny (1941) formulated the following equation :

$$S = f(cl, o, r, p, t, ...)$$

Where, S – any soil property, such as pH, N, clay etc.
Cl – environmental climate ;
o – organisms and vegetation (biosphere)
r – relief or topography p – parent material
t – time
--- – additional unspecified factros (Like fire, storms etc.)

Passive soil forming factors :

1. Parent material : It differ as widely as rock of the earth crust. The parent material transported from their place of origin are named according to the main force responsible for the transport and redeposition.
2. Relief of Topography: They denote the configuration of the land surface. The relief units are geomorphologically the distinct areas, such as an undulating plain, an escarpment or an alluvial plain. It may be described in terms of relative relief, drainage spacing, slope and slope angles. It also refers to the differences in elevation of the land surface on a broad scale.
3. Time : Soil formation is very slow process requiring thousand of years to develop a mature pedon. The period taken by a given soil from the stage of weathered rock up to the stage of maturity is considered as time.

a) Draw well labeled diagram of soil profile. Explain master horizons. 4 Marks

"O"- organic horizon of mineral soil..

"A"- Mineral horizon formed at near the surface with well mix organic matter.

"B"- Subsurface horizon showing typical colour, texture , structure.

"C"- Parent material including bed rock.

b) Define soil texture and give its importance in agriculture. 4 Marks

Defination – It refers to relative percentage of sand, silt and clay.

Importance : Texture has good effect on management and productivity of soil. Sandy soils are of open character, usually loose and friable. Such type of the texture is easy to handle for tillage operation and facilitate drainage and aeration. Clay particles in clayey soils plays important role in soil fertility but difficult to till and required much skill in handling. They have a high water holding capacity and poor percolation which turns in waterlogging. Silt is very valuable constituent of soil. In drainage, absorption of water and water holding capacity it is intermediate between sandy and clayey soils. Tillage operations are best for such class of soil.

Q.5 a) Explain in detail about land capability classification. 4 Marks

There are eight land capability classes, which are numbered from I to VIII. Those lands, which have the maximum capabilities and the least limitations, are placed in class 1, whereas those lands, which have the maximum limitations and the least capabilities, are placed in class VIII. Class I to Class IV encompasses land suitable for cultivation, unit class V to Class VIII includes land unsuitable for cultivation but suitable for grazing, permanent vegetation and wild life.

b) Define soil structure. Write significance of soil aggregation in agriculture. 4 Marks

Soil structure: The arrangement and organization of primary and secondary particles in a soil mass is known as soil structure.

The role of soil structure in relation to plant growth is Soil structure influences the amount and nature of porosity.

1. Structure controls the amount of water and air present in the soil. Not only the amount of water and air dependent on soil structure, but their movement and circulation are also controlled by soil structure.
2. It affects tillage practices.
3. Structure controls runoff and erosion.
4. Platy structure normally hinders free drainage whereas spherelike structure (granular and crumby) helps in drainage.
5. Crumby and granular structure provides optimum infiltration, water holding capacity, aeration and drainage. It also provides good habitat for microorganisms and supply of nutrients.

Q.6 a) Define soil survey. Explain different types of soil survey. 4 Marks

Soil survey is a study and mapping of soils in their natural environment. It is the systematic examination, description, classification and mapping of soils of an area.

Types of soils survey

Depending upon the objective, method, type of base map available and the intensity of observations, four major types of soil surveys are recognised. They are :

1. Detailed
2. Reconnaissance
3. Detailed-reconnaissance [a combination of (1) and (2) above]
4. Semi-detailed

b) Enlist different soil orders. Explain the characteristics of Vertisols. 4 Mar

Name of Soil order

Major characteristics

1. Entisols
2. Inceptisols
3. Mollisols
4. Alfisols
5. Ultisols
6. Oxisols
7. Vertisols
8. Aridisols
9. Spodsols
10. Histosols
11. Andisols
12. Gelisols

Vertisols

High is swelling clays, deep cracks when soil dry.

Q.7 a) Explain in brief different soil moisture constants. 4 Marks

Soil Moisture Constants

The amount of water that a soil contains at each of these equilibrium points is known as a soil moisture constant.

Following are the soil moisture constants.

1. Field capacity:
2. Wilting coefficient:
3. Hygroscopic coefficient:
4. Available water capacity:
5. Maximum water holding capacity
6. Sticky point moisture :

b) What do you mean by available water. Explain unsaturated flow of water. 4 Marks

Available water capacity: The amount of water required to apply to a soil at the wilting point to reach the field capacity is called the "available" water. The water supplying power of soils is related to the amount of available water a soil can hold. The available water is the difference in the amount of water at field capacity (- 0.3 bar) and the amount of water at the permanent wilting point (- 15 bars).

Unsaturated Flow

It is flow of water held with water potentials lower than- 1/3 bar. Water will move toward the region of lower potential (towards the greater "pulling" force). In a uniform soil this means that water moves from

wetter to drier areas. The water movement may be in any direction. The rate of flow is greater as the water potential gradient (the difference in potential between wet and dry) increases and as the size of water filled pores also increases. The two forces responsible for this movement are the attraction of soil solids for water (adhesion) and capillarity. Under field conditions this movement occurs when the soil macropores (noncapillary) pores with filled with air and the micropores (capillary) pores with water and partly with air.

Define soil colloids. Enlist the general properties of soil colloids

Q.8 a) **Soil Colloids**

The clay fraction of the soil contains particles less than 0.002 mm in size. Particles less than 0.001 mm size possess colloidal properties and are known as soil colloids. 4 Marks

General Properties of Soil Colloids

1. Size:
2. Surface area:
3. Surface charges: The negative electrical charge on clays comes from i) Ionizable hydrogen ions and ii) Isomorphous substitution.
   iii. Broken bonds
4. Adsorption of cations:
5. Adsorption of water:
6. Cohesion
7. Adhesion:.
8. Swelling and shrinkage:
9. Dispersion and flocculation:
10. Brownian movement:.
11. Non permeability

b) What is ion exchange? Give the importance of CEC in agriculture.

Ion Exchange

An element with an electrical charge is called an ion. Potassium, sodium (Na), hydrogen (H), Ca and Mg all have positive charges. They are called cations and ions with negative charges, such as nitrate and sulfate, are called anions. 4 Marks

Importance of Cation Exchange

When fertilizers are applied to supply plant nutrients elements like K, Ca, Mg and NH4 dissolve in soil solution. These nutrients in soil solution are exchanged for other cation like H+ present in the exchange complex. If there is no cation exchange the applied nutrients would be lost in drainage water. Similar is the case with anion radicals like PO4, NO3, SO4 etc. Soils with high CEC can adsorb higher amounts of nutrients. Hence, in clay soils we can apply larger quantities of fertilizers in a single dose. Sandy soils have very low CEC and in such soils fertilizers should be applied in splits.

Q.9 a) Give the composition of plant residue and enlist the sources of soil organic matter.

Composition of organic residues:

Plant residues contain 75% moisture and 25% dry matter. This 25% is made up of Carbon (10-12%), Oxygen (9-10%) , Hydrogen (1.5-2.5%) , N(1-2%) and mineral matter (1-3%). 4 Marks

Plant tissue is the major source. Animals are considered as secondary sources. They attack original plant tissues, contribute w/s products and leave their own bodies after death.

b) Define soil biology. Explain in brief the management practices fo improving microbial activity.

Soil biology is the study of microbial and faunal activity and ecology in soil. These organisms include earthworms, nematodes, protozoa, fungi and bacteria.

Soil biology plays a vital role in determining many soil characteristics yet, being a relatively new science, much remains unknown about soil biology and about how the nature of soil is affected.

Management practices for improving microbial activity.

Q.10 a) Define soil pollution. Enlist the different sources of soil pollution.

The presence of toxic chemicals in the soil in very high concentration which risk to human health and the eco system is known as soil pollution. 4 Mar

Sources of soil pollution : 1. Pesticides, insecticides, herbicides 2. Fertilizers 3. Waste water for irrigation 4. Agricultural plastic waste 5. Rural community waste 6. Industrial waste 7. Waste water from town 8. Solid waste plastic 9. Acid rain 10. Mining.

b) Enlist different thermal properties of soils. What is the significance of soil temperature in agriculture.

Thermal properties of soils The thermal properties of soils are a component of soil physics that has found importants uses in engineering, climatology and agriculture. These properties influence how energy is partitioned in the soil profile. While related to soil temperature, it is more accurately associated with the transfer of heat throughout the soil, by radiation, conduction and convection. Main soil thermal properties: 4 Marks

Volumetric heat capacity, SI units: Jm-3K-1
Thermal conductivity, SI units: W.m-1K-1
Thermal diffusivity, SI units: m2.s

Soil Temperature

Soil temperature is an important plant growth factor like air, water and nutrients. Soil temperature affects plant growth directly and also indirectly by influencing moisture, aeration, structure, microbial and enzyme activities, rate of organic matter decomposition, nutrient availability and other soil chemical reactions. Specific crops are adapted to specific soil temperatures. Apple grows well when the soil temperature is about 18°C, maize 25°C, potato 16 to 21°C, and so on.

SECTION "B"

(8 Marks)

Q.11 Do as directed.

1) Give one example of 2:1 type of clay mineral.
   Montmorillonite
2) Who is known as father of Soil Science?
   V. Dokuchaiev
3) What is streak?
   Colour of powder of mineral
4) Which are the sources of soil heat ? (Any One)
   Solar radiation/ conduction/ chemical & biological reactions /and rain.
5) The relative purity or strength of spectral colour is known as
   Chroma.
6) Name the two dominant soil orders in Maharashtra
   Inceptisol, Vertisol, Entisols
7) Enlist the agents of physical weathering (Any Two)
   Physical condition of rock, action of temperature, action of water, action of freezing, action of glaciers, action of wind & sand blast.
8) State the size of silt and fine sand particles.
   Silt : 0.02 to 0.002, fine sand : 0.20 to 0.02

(8 Marks)

Q.12 Define

1. **Regolith** – The unconsolidated mantle of weathered rock and soil materials on the earths surface : loose earth materials above solid rock.
2. **Soil consistency**- Soil consistence represents at varying moisture conditions. the degree and kind of cohesion and adhesion of soil material.
3. **Soil pH** - Negative logarithm of active hydrogen ion concentration.
4. **Soil taxonomy**- A comprehensive system of soil classification based on the properties of soils.
5. **Hydrolysis**- An increase in H ion concentration results in the accelerated hydrolytic action of water.
6. **Specific heat**-The quantity of heat required to raise the temperature of one gram of a substance by one celcius degree.
7. **C:N ratio** -The ratio of the weight of organic carbon (C) to the weight of total nitrogen (N) in a soil (or organic material), is known as C : N ratio
8. **Light mineral**- The minerals having specific gravity less than 2.85 g cc^{-1} are known as light minerals.

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