EXTENDED LECTURE OUTLINE

SAC6 311 **Fundamentals of Soil Science** **(1+1)**

Syllabus

Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; soil survey, types, methods of soil survey Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, soil organisms: macro and micro organisms, their beneficial and harmful effects;

Practicals:

Study of general properties of minerals, Study of silicate minerals, Study of non-silicate minerals, Study of igneous rocks, Study of sedimentary rocks, Study of metamorphic rocks, Study of soil sampling tools and collection of representative soil samples, Study of soil profile, Determination of soil moisture content, Determination of bulk density and particle density and porosity of soil, Study of soil texture by feel method, Study of soil texture by bouyoucos method, Determination of soil colour, Study of capillary rise phenomenon of water in soil column and water movement in soil, Demonstration of heat transfer in soil, Study of soil map

LECTURE SCHEDULE

Introduction to course on soil science - Introduction and importance of soil science, concepts of soils, soil as a natural body, soil as a three dimensional body, scope and branches of soil science. Soil – Definition by Hillgard, Joffe and Marbut, Glossary of soil science terms/ SSSA (1970), FAO, Blum, Dokuchaev (1900), Buckman and Brady and Pedologists. Two approaches of soil study- Edaphological and Pedological aspects of soil science. Components of soil.

Minerals- Definition, important rock forming minerals, formation of minerals, classification of minerals based on quantity, mode of origin, specific gravity (light minerals, heavy minerals) and chemical composition. Ferro magnesium and non ferro magnesium minerals. Study of primary minerals, Silicate minerals-orthosilicates, inosilicates, phyllosilicates, tectosilicates -quartz, feldspar, micas, pyroxenes, amphiboles and olivines. Study of secondary minerals- Silicates and non silicates. Silicate clay minerals- kaolinite, montmorillonite, illite. Non silicate minerals- oxides- haematite, limonite, goethite and gibbsite, carbonates- calcite, dolomite, sulphates- gypsum, phosphates- apatitie. Classification of clay minerals.

Rocks- Petrology, Rocks and its definition, formation of rocks, rock cycle, soil forming rocks and classification based on mode of origin -Igneous, Sedimentary and Metamorphic rocks.

Igneous rocks: Definition, formation of igneous rocks, classification based on mode of origin - extrusive rocks (volcanic rocks) and intrusive rocks (plutonic rocks), Bowen reaction, classification of rocks based on chemical composition/ silica content- acidic rocks, basic rocks, intermediate rocks (sub acidic, sub basic rocks) and ultra basic rocks. brief description of important igneous rocks-basalt, pumice and granite.

Sedimentary rocks: Definition, formation of sedimentary rocks / stages of formation, 4 stages (1.Weathering, 2. Transportation, 3. Deposition or sedimentation, 4.Diagenesis). Classification of rocks based on I) origin – i) Fragmented, Detrital or mechanically formed and ii) Chemically formed – a) inorganically formed b) organically or biochemically formed rocks. Aqueous rocks - arenaceous rocks, argillaceous rocks, calcareous rocks, carbonaceous rocks, siliceous rocks and precipitated rocks. Brief description of important sedimentary rocks: conglomerate rocks, sand stone, shale and limestone.

Metamorphic rocks: Definition, Formation- three groups of metamorphic rocks: a) Hydromorphic rocks b) Thermo metamorphic rocks c) Dynamometamorphic rocks. classification of rocks based on texture and structure of minerals – foliated: coarse grained-gneiss, coarse grained -schist, medium grained- phyllite, very fine grained- Slate, unfoliated (massive structure): fine grained (Anthracite, Talc, Amphibolite), granular: medium coarse grained(Quartizite) , Fine grained (Marble), Brief description of important metamorphic rocks -gnesis, schist, marble and slate.

Weathering of rocks and minerals

Weathering- Definition , two processes involved in soil formation. Three types of weathering – physical or mechanical, chemical and biological weathering, Physical weathering agents and their role-temperature, water, wind, glaciers and atmospheric electric phenomenon. Chemical weathering agents and their role: hydration, hydrolysis, solution, carbonation, oxidation and reduction, biological weathering agents and their role: man and animals, higher plants and their roots, micro-organisms.

Weathering of minerals: Factors influencing weathering of minerals - climatic conditions, physical characteristics of minerals (differential composition, particle size and hardness (degree of cementation), chemical and structural characteristics (Feldspar and ferromagnesian minerals, Quartz), tightness of packing of ions in crystals. Weathering products of silicate minerals, weathering sequence . Stages in the weathering of soil minerals- early weathering intermediate weathering and advance weathering stages.

Soil formation: Soil formation - two stages (weathering of rock (R) into regolith and formation of true soil from regolith. Soil forming factors equation given by Jenny (1941) – S=F (Cl, O, R, P, T,---), classification of soil forming factors – active and passive. Passive soil forming factors – parent material-endo-dynamomorphic and ecto-dynamomorphic soils, soil properties as influenced by parent material. Parent material – colluvium, alluvium, lacustrine, moriane, loess or aeolian, marine, dunes (sand & silt), till. Soil properties as influenced by parent material a) Profile development b) silica :sesquioxide ratioc) soil texture d) clay. Topography- types, slope classes, soil formation on sloping lands, level topographic positions, depressions, soil formation and exposure/aspect. Topo sequence b) catena.
Time- weathering stages in soil formation. Active soil forming factors climate-precipitation-relationship of soil properties and precipitation, temperature- relationship of soil properties and temperature. Vegetation and organisms- vegetation and soil formation, macro-organisms and soil formation, micro-organisms and soil formation, man and soil formation.

Soil forming processes –pedogenic processes- basic soil forming processes – gains/addition, losses, transformation, translocation, fundamental soil forming processes-humification, elluviation, illuviation, calcification, decalcification, podzolization, laterization, gleization, salinization, desalinization, solonization or alkalization, solodization or dealkalization, pedoturbation.

Soil profile - soil profile, soil horizons, genetic horizons-master horizons, transitional and combination horizons, and subordinate distinction within master horizons. Cross sectional view of soil profile. Schematic diagram of soil profile. New and old horizon designations and brief description.

Soil physical properties-Soil texture: Definition and importance of soil separates- sand, silt and clay. Classification of soil separates based on International Society of Soil Science (ISSS), United States Department of Agriculture (USDA), British Standards Institutions

(BSI) and United States Public Roads Administrations (USPRA). Physical, chemical and mineralogical nature of soil separates.

Mechanical analysis –Principle, Stokes law, derivation of Stokes law, assumptions and limitations of Stokes law. Methods of mechanical analysis : International pipette method and Hydrometer method. Textural properties and behaviour of soils, Study of textural class using soil textural triangle. Determination of soil texture by feel / field method. Practical implications of mechanical analysis. Importance of soil texture in relation to plant growth and development, factors affecting soil texture and management of soil texture.

Soil structure: Definition, importance, formation of soil structure- mechanism of aggregate formation, classification of soil structure- type, class and grade. Types of soil structure plate like/platy, prism like/prismatic, block like blocky, spheroidal –sphere like, classes of structure- very fine or very thin, fine or thin, medium, coarse or thick , very coarse or very thick, grades of structure – structureless, weak, moderate and strong, factors affecting soil structure, effect of soil structure on other physical properties. Genesis of soil structure, factors influencing genesis of soil structure and aggregate formation. Evaluation of soil structure. Indices of soil structure. Role of soil structure in relation to plant growth and development and management of soil structure.

Soil Consistency – Definition, forces causing consistency-cohesion and adhesion. Factors affecting consistency. Forms of consistency. Consistency in relation to different soil moisture regimes – wet soils – stickyness and plasticity, moist soils and dry soils, cementation, scouring point. Laws of plastic flow and film theories of plasticity. Atterberg limits- upper plastic limit, lower plastic limit, plasticity number/index, significance of Atterberg limits, factors affecting Atterberg limits.

Soil Density – Definition, types of soil density - particle density, bulk density, their relationship. Factors affecting bulk density and particle density and its importance. Determination of bulk density and particle density by core method. Calculation of bulk density and particle density.

Soil porosity -Definition, types of soil pores- macropores and micropores(capillary pores), biopores, factors affecting porosity of soil , its importance , relationship between porosity and densities of soil and calculation of porosity.

Soil colour-Definition , kinds of colour, factors influencing soil colour, components of soil colour- HUE, VALUE and CHROMA, determination of soil colour, conditions for measuring soil colour.

Soil Temperature: Sources of soil heat: solar radiation, biochemical reaction, conduction, precipitation, exposure and vegetation. **Loss of soil heat:** radiation, conduction, evaporation and precipitation. Factors influencing soil temperature. **Thermal properties soil:** specific heat, heat capacity, thermal conductivity and thermal diffusivity. Diurnal and annual variations of soil temperature, Fouriers law, Influence of soil temperature on plant growth and development, measurement of soil temperature, management of soil temperature

Soil crusting: Definition, mechanism of crust formation, adverse effects of soil crusting. Management of soil crusting.

Soil Air -Definition of soil aeration, composition of soil air, factors affecting the composition of soil air, exchange of gases between soil and atmosphere- mass flow and diffusion, reasons for poor aeration, importance of soil aeration in relation to plant growth and activity of microorganisms. Management of soil aeration. Oxygen diffusion rate (ODR). Factors influencing ODR. Practical implication of ODR. Ficks law of diffusion of gases.

Soil water-Importance of soil water, retention of water by soil, soil water potential, methods of expressing suctions, measuring of soil moisture, in laboratory and field. Classification of soil water - physical classification (gravitational water, capillary water, hygroscopic water). Factors affecting gravitational, capillary and hygroscopic water, biological classification of water- available water, unavailable water, super available or superfluous water. Soil moisture constants -field capacity, wilting coefficient, hygroscopic co-efficient, available water capacity, maximum water holding capacity, sticky point moisture of oven dry soil. Entry of water into soil- infiltration, factors affecting infiltration, percolation, hydraulic conductivity, soil water movement- saturated flow, unsaturated flow, water vapour movement, factors affecting movement of water, vertical water flow, unsaturated flow, water vapour movement. Darcy' s Law.

Soil Organisms: Macro & Microorganisms (Beneficial & Harmful organisms)

Soil Survey and mapping - Definition, Importance of soil survey, purpose of soil survey, base maps, cadastral maps, aerial photographs, soil mapping units, soil series, soil association, soil complex, soil type, soil phase, land types, inclusions, variants. Methods of soil survey- grid survey, free survey. Types of soil survey- reconnaissance, detailed, detailed-reconnaissance, semi detailed, exploratory and rapid reconnaissance.

Soil Classification- Purpose of classification, systems of soil classification- early systems of soil classification – economic classification, physical classification, geological classification, physiographic classification, recent systems of classification- Dokuchaev's system(1900), Coffey's (1912), marbut's morphogenetic system (1935), Baldwin, Kellog and Thorp (1938), Thorp and Smith (1949), Limitations of Genetic system of classification.

Soil Taxonomy – Definition, 7^{th} approximation or modern system of classification, salient features, structure-higher categories (order, suborder and great group), Lower categories (sub-group, family and series), application of differentiating criteria used in six categories, criticism, appreciation.

Soil Horizons- Horizon designation, diagnostic horizons- diagnostic surface horizons (Epipedons), diagnostic subsurface horizons (endopedons), salient characteristics and differentiating properties of different soil orders (12), formative elements of soil orders, soil moisture and temperature regimes, brief description of soil orders- Alfisol, Andisol, Aridsol, Entisol, Gelisol, Histol, Inceptisol, Mollisol, Oxisol, Spodosol, Ultisols and Vertisols

Soils of India and Karnataka- Major groups of soils- black soils, red soils, laterite soils, forest and mountain soils, Arid and desert soils, Saline and alkaline soils, peaty and marshy soils.

Lecture Outline

	Topics
	Soil Science: definition, introduction, importance, scope and branches
	Soil: Definition, Soil a natural body, edaphalogical and pedological concepts of soil, components of soil.
	Minerals: definition, occurrence, classification of minerals based on abundance, specific gravity, mode of origin and chemical composition, study of silicate and non-silicate minerals (types and their composition)
	Rocks: definition, formation, occurrence and classification of rocks based on mode of origin. Igneous rocks, Sedimentary rocks and Metamorphic rocks, their classification
	Weathering of rocks and minerals: definition, types- physical, chemical and biological weathering, factors influencing weathering, products of weathering, weathering sequence
	Soil formation: factors of soil formation, active factors like climate, organisms and passive factors like parent materials, topography and time.
	Pedogenic processes of soil formation: basic/ fundamental processes and specific pedogenic processes
	Soil profile: master horizons, transitional horizons and subordinate horizons
	Soil physical properties: Soil texture- definition, soil separates (USDA and ISSS) and their properties. Particle size analysis – Stoke's law; derivation, assumptions and limitation of Stoke's law. Textural classes.
	Soil structure: classification based on types, class and grade, importance, mechanism of aggregate formation, factors affecting soil structure and evaluation of soil structure. Management of soil structure.
	Soil density: particle density, bulk density; their relationships, factors influencing soil density and importance
	Soil porosity: definition, types of pores, factors affecting porosity and importance
	Soil colour: Attributes (hue, value and chroma), importance, factors affecting soil colour

	S**oil consistency:** forms (Hard, soft, plastic and sticky consistency), factors affecting consistency, Atterberg's limits, and significance.
	Soil air: composition, importance, mechanism of gaseous exchange and management.
	Soil temperature: Source, amount, factors influencing soil temperature, flow of heat, thermal properties of soil and its importance/management in plant growth
	Soil water: classification, soil moisture constants, movement and availability of soil water, infiltration, percolation and hydraulic conductivity
	Soil Organisms: Macro & Microorganisms (Beneficial & Harmful organisms)
	Soil survey: types, methods and purpose of soil survey
	Soil classification: USDA system of classification (Soil taxonomy); salient features, structure of soil taxonomy, formative elements and their meaning, epipedons, endopedons, soil moisture and soil temperature regimes, keys to soil orders and salient characteristics of Inceptisols, Entisols, Alfisols and Vertisols.
	Soils of India and Karnataka