SRIDEV SUMAN UTTARAKHAND UNIVERSITY
BADSHAHITHAUL TEHRI GARHWAL

SYLLABUS FOR
M.SC (AGRI) SOIL SCIENCE

M.Sc. (Agriculture) – Soil Science

COURSE STRUCTURE – AT A GLANCE

FIRST SEMESTER M.M.: 600

PAPER – 101: Basics of Soil Science
PAPER – 102: Soil Mineralogy, Genesis, Classification and Survey
PAPER – 103 : Soil Chemistry
PAPER – 104 : Soil Biology & Biochemistry
PAPER – 105 PRACTICAL I ,
PAPER – 106 PRACTICAL II,

M.Sc. (Agriculture) – Soil Science

COURSE STRUCTURE – AT A GLANCE

SECOND SEMESTER M.M.: 600

PAPER – 201 Analytical Techniques and Instrumental methods in Soil and Plan analysis,
PAPER – 202, Soil Fertility and Fertilizer Use,
PAPER – 203, Advance Soil Physics,
PAPER – 204, Management of Problem Soils and Waters,
PAPER – 205 PRACTICAL I,
PAPER – 206 PRACTICAL –II,

SRI DEV SUMAN UNIVERSITY BADSHAHITHAUL (TEHRI GARHWAL)

M.Sc. (Agriculture) – Agronomy

COURSE STRUCTURE – AT A GLANCE

THIRD SEMESTER M.M.: 600

PAPER – 301, Fertilizer Technology,
PAPER – 302, Land degradation and Restoration
PAPER – 303, Remote Sensing and GIS Techniques for Soil, Water and Crop Studies
PAPER – 304, Advances in Soil Fertility
PAPER – 305, PRACTICAL- I,
PAPER – 306 , PRACTICAL –II,

SRI DEV SUMAN UNIVERSITY BADSHAHITHAUL (TEHRI GARHWAL)

M.Sc. (Agriculture) – Agronomy

COURSE STRUCTURE – AT A GLANCE

FOURTH SEMESTER M.M.: 600

PAPER – 401 Biochemistry of Soil Organic Matter,
PAPER – 402 Basic Statistics,
PAPER – 403 SEMINAR ,
PAPER – 404 THESIS (THESIS & VIVA – VOCE),
PAPER – 405 PRACTICAL,

SRI DEV SUMAN UNIVERSITY BADSHAHITHAUL (TEHRI GARHWAL)

M. Sc. Ag. Examination in Soil Science
PROPOSED REGULATIONS
Semesters/Papers Title of the papers

SEMESTER I

Sn.No	Subject Name	Subject Code No	Total Marks	Theory Marks	*Internal Marks*	Mini. Passing marks	Credit
1	Basics of Soil Science	Paper 101	100	60	40	40	3
2	Soil Mineralogy, Genesis, Classification and Survey	Paper 102	100	60	40	40	3
3	Soil Chemistry	Paper 103	100	60	40	40	3
4	Soil Biology & Biochemistry	Paper 104	100	60	40	40	3
5	PRACTICAL I	Paper 105	100 P	60	40	40	2
6	PRACTICAL II	Paper 106	100 P	60	40	40	2

Total aggregate of First Semester is 45% Max. Marks – 600, Min.Marks – 250

MscAgSoil 101
102
103
104

M. Sc. Ag. Examination in Soil Science
PROPOSED REGULATIONS
Semesters/Papers Title of the papers

SEMESTER II

Sn.No	Subject Name	Subject Code No	Total Marks	Theory Marks	*Internal Marks*	Mini. Passing marks	Credit
1	Analytical Techniques and Instrumental methods in Soil and Plant analysis,	Paper 201	100	60	40	40	3
2	, Soil Fertility and Fertilizer Use	Paper 202	100	60	40	40	3
3	Advance Soil Physics,	Paper 203	100	60	40	40	3
4	Management of Problem Soils and Waters,	Paper 204	100	60	40	40	3
5	PRACTICAL I	Paper 205	100 P	60	40	40	2
6	PRACTICAL II	Paper 206	100 P	60	40	40	2

Total aggregate of First Semester is 45% Max. Marks – 600, Min.Marks – 250

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M. Sc. Ag. Examination in Soil Science
PROPOSED REGULATIONS
Semesters/Papers Title of the papers

SEMESTER III

S.N.No	Subject Name	Subject Code No	Total Marks	Theory Marks	*Internal Marks*	Mini. Passing marks	Credit
1	Fertilizer Technology,	Paper 301	100	60	40	40	3
2	Land degradation and Restoration,	Paper 302	100	60	40	40	3
3	Remote Sensing and GIS Techniques for Soil, Water and Crop Studies	Paper 303	100	60	40	40	3
4	Advances in Soil Fertility,	Paper 304	100	60	40	40	3
5	PRACTICAL I	Paper 305	100	60	40	40	2
6	PRACTICAL II	Paper 306	100	60	40	40	2

Total aggregate of First Semester is 45% Max. Marks – 600, Min.Marks – 250

M. Sc. Ag. Examination in Agronomy
PROPOSED REGULATIONS
Semesters/Papers Title of the papers

SEMESTER IV

Sn.No	Subject Name	Subject Code No	Total Marks	Theory Marks	*Internal Marks*	Mini. Passing marks	Credit
1	Biochemistry of Soil Organic Matter,	Paper 401	100	60	40	40	3
2	Basic Statistics	Paper 402	100	60	40	40	3
3	SEMINAR	Paper 403	100	60	40	40	3
4	THESIS (THESIS & VIVA – VOCE FARMING	Paper 404	200	130 +50	20		2
5	PRACTICAL	Paper 405	100	60	40	40	2

Total aggregate of First Semester is 45% Max. Marks – 600, Min.Marks – 250

1st SEMESTER

Course Title	:	**Basics of Soil Science**
Course No.	:	**SDSU-101**
Credit Hours	:	**3(2-0-1x3)**

Syllabus

Soil as a natural body : Soil components and soil-plant relationship; soil forming rocks and minerals, weathering and processes of soil formation; physical properties of soil-texture, structure, density and porosity, soil colour, consistence and plasticity; soil reaction pH and its measurement, soil acidity and alkalinity, buffering, K effect of pH on nutrient availability; soil colloids – inorganic and organic; silicate clays constitution and properties; humic substances – nature and properties, ion exchange, cation exchange capacity, base saturation; soil organic matter : Composition, properties and influence on soil properties: microbiology transformation of organic and inorganic constituents of soil; biological nitrogen fixation; recycling of organic wastes in soils.

Soil water retention, dynamics and availability; soil air – composition and dynamics; source, amount and flow of heat in soil; soil temperature and plant growth;

Soil fertility, problems of soil fertility in India; plant growth and development, factors affecting plant growth; essential plant nutrients, their role and deficiency and toxicity symptoms; movement of nutrients from soil to plant roots, their uptake and translocation.

Chemistry of soil nitrogen, mineralization and immobilization of N, P and K in soil chemistry of secondary and micronutrients in soil, in retreated nutrient management; soil pollution, properties of fertilizes and their uses.

Course Outline

A. Lectures

S.No.	Topic	No. of lectures
1.	***Soil composition its Development***: a. Soil as a natural body and its components b. Soil profile and Soil Plant relation c. Rocks and minerals, parent material weathering factors and processes of soil formation	4
2.	***Physical Properties***: Soil texture, structure, density, porosity, colour consistence, adhesion, cohesion and plasticity	2
3.	***Soil Colloids:*** a. Inorganic and organic colloids	2

	b. Ion exchange phenomenon and nutrient availability	
4.	***Soil reaction***: a. Soil pH, Soil acidity, buffering and liming b. Soil salinity and sodicity c. Nutrients availability and plant growth	2
5.	***Soil Water***: a. Soil water retention and measurement b. Movement of soil water c. Water availability to plants d. Vapour and liquid losses and their control	2
6.	***Soil air***: a. Composition of soil air b. Soil aeration and plant growth	2
7.	***Soil Temperature***: a. Source, amount and flow of heat in soil b. Soil temperature and plant growth	2
8.	Brief history of plant nutrient; soil fertility – past and present; nutrient application in crop production; plant growth and development; factors affecting plant growth essential plant nutrients; their role, their deficiencies, toxicities and imbalance	3
9.	***Soil organisms***: a. Macro- and micro-organisms b. Microbiological transformations of organic and inorganic constituents of soils c. Biological nitrogen fixation	2
10.	***Soil organic matter and recycling of organic wastes***: a. Source and composition, C:N ratio, mineralization and immobilization b. Humus c. Influence on soil properties	2
11.	Nutrient transport from soil to plant roots; nutrient uptake and translocation in plant.	1
12.	Mineralization and immobilization of soil nitrogen, phosphorus and potassium	3
13.	Transformation of secondary and micronutrients in soil	3
14.	***Properties and uses of fertilizer:*** a. Properties of fertility and their use b. Quality control c. Fertilizer application methods d. Efficient use of fertilizer	3
15.	***Soil fertility problems and their management***: a. Problems of soil fertility in India and their management b. Effects of continuous use of inorganic and organic nutrients sources on soil fertility c. INM	3
		36

	Hourlies	**02**
A. Practicals	**Total**	**38**

Sl.No.	Topic	No. of Practicals
1.	Estimation of total nitrogen in soil	1
2.	Study of soil sampling tools, collection of representative soil sample, its processing and storage.	2
3.	Estimation of available nitrogen in soil and alkaline permanganate method	1
4.	Study of soil density and porosity	1
5.	Study of soil texture by Feel and Bouyoucos Methods	1
6.	Estimation of available phosphorus in soil	1
7.	Estimation of available potassium in soil	1
8.	Estimation of available sulphur in soil	1
9.	Determination of available micronutrients cations in soil	1
10	Determination of total N in fertilizer	1
11.	Study of soil reaction by indicators and glass electrode pH matter	1
12.	Study of soil colour	1
13.	Demonstration of heat transfer in soil	1
14.	Estimation of organic matter content of soil	1
15.	Determination of water soluble P in fertilizer	1
16.	Determination of water soluble K in fertilizer	1
	Total	**17**
	Practical Final	**1**
		18

References:

Jones, U.S. 1987. Fertilizers and Soil Fertility (2nd Ed.). Printice Hall, New Jersey
Kanwar, J.S. (ed.) 1976. Soil Fertility Principles and Practices. ICAR, New Delhi.
Tisdale, S.M. ; Nelson, N.L. : Beaton, J.D. and Havlin, G.H. 1993. Soil Fertility and Fertilizers (5th Ed.) Prentice Hall of India Pvt. :Ltd., New Delhi.

Course Title : Soil Mineralogy, Genesis, Classification and Survey

Course No. : SDSU- 102
Credit Hours : 3(2-0-1x3)

Syllabus

Basic structure of alumino-silicate minerals and Genetic factors of soil formation, soil forming processes and reactions, classification and nomenclature of soils, properties and distribution of the major soil groups of the world with emphasis on tropical and sub-tropical soils. Study of soil as a natural body: morphological, physical and chemical properties used in distinguishing and classifying solids. Standard soil surveys and preparation of soil maps, special purpose surveys, aerial photo use and interpretation, characteristics, classification and distribution of different soils in India with emphasis on the soils of Uttarakhand.

Lectures

Sl. No.	Lecture topic	Cr. Hr.
1.	Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.	4
2.	Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils.	6
3.	Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.	6
4.	Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.	8
5.	Soil survey and its types; soil survey techniques – conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.	6
6.	Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.	6

Practicals

Sl. No.	Practical topic	Cr. Hr.
1.	Identification and quantification of minerals in soil fractions	2
2.	Morphological properties of soil profile in different landforms	2

3.	Classification of soils using soil taxonomy	2
4.	Calculation of weathering indices and its application in soil formation	2
5.	Grouping soils using available data base in terms of soil quality	2
6.	Aerial photo and satellite data interpretation for soil and land use	2
7.	Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales	2
8.	Land use planning exercises using conventional and RS tools	2
	Lab Final	1
	Total	**17**

References:

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.

Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

Course Title : Soil Chemistry

Course No. : SDSU-103
Credit Hours : 3 (2-0-1x3)

Syllabus

Composition and constitution of soil; classical concepts of soil chemistry; physico-chemical and electrokinetic properties of colloids; ion exchange phenomena and equilibrium reactions; oxidation-reduction potentials.

Lectures

Sl. No.	Lecture description	Hrs.
1.	Chemical (elemental) composition of earth's crust and soils	1
2.	Elements of equilibrium thermodynamics, chemical equilibria, colligative properties, electrochemical properties – electrophoresis, electroosmosis, sedimentation and chemical kinetics.	3
3.	Soil colloids: their formation; inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids and structure and properties of diffuse double layer, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions	8
4.	Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – inner-sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena and practical implications in plant nutrition.	7
5.	Adsorption/desorption isotherms - Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).	5
6.	Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects	3
7.	Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).	3
8.	Chemistry of acid soils; active and potential acidity; lime potential; sub-soil acidity	2
9.	Chemistry of salt-affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments	2

10.	Oxidation and reduction processes in soil; chemistry and electrochemistry of submerged soils	2
	Hourlies	02
	Total	**36**

Practicals

S. No.	Practical	Hrs.
1.	Analysis of equilibrium soil solution for pH, EC and Eh by Eh-pH meter and conductivity meter	1
2.	Determination of CEC and AEC of soil	2
3.	Determination of point of zero charge and associated surface charge characteristics by the serial potentiometric titration method.	2
4.	Potentiometric and conductometric titration of soil humic and fulvic acids	1
5.	The (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the Δ (E_4/E_6) values at two pH values.	2
6.	Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm	2
7.	Determination of phosphate potential of soil	2
8.	Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method.	1
9.	Determination of lime requirement of an acid soil by buffer method.	1
10.	Determination of gypsum requirement of an alkali soil.	1
	Final Practical	1
	Total	**16**

References:

1. Bear, F.E. 1964. Chemistry of the Soil.
2. Jurinak, J.J. 1978. Chemistry of Aquatic Systems. Dept. of Soil Science & Biometeorology, Utah State Univ.
3. Marshall, C.E. The Physical Chemistry and Mineralogy of Soil.
4. McBridge M.B. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.
5. Sparks, D.L. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.
6. Sposito, G. 1981. The Thermodynamics of Soil Solutions. Oxford Univ. Press.
7. Sposito, G. 1984. The Surface Chemistry of Soils. Oxford Univ. Press.
8. Stevenson, F.J. 1994. Humus Chemistry. 2nd Ed. John Wiley.
9. Tan, K.H. Principles of Soil Chemistry.
10. Van Olphan, H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

Course Title: **Soil Biology and Biochemistry**
Course No. : **SDSU-104**
Credit Hrs. : **3(2-0-1x2)**

Syllabus

Soil biota, soil microbial ecology, microorganism in soil their growth and interactions, Soil microbial biomass; unculturable soil biota. Biotic factors in soil development. Microbiology and biochemistry of root soil interface, phyllosphere. Soil enzymes: Origin, importance and activities; soil characteristics influencing growth and activity of micro-flora: Microbes in biogeochemical cycles in soil- nitrogen, phosphorus, sulphur, iron & manganese. Soil organic matter: biochemical composition and biodegradation; humus formation. Biogas production from organic wastes:microbiology and biochemistry. Organic manures: farm yard manure, animal manures, rural & urban composts & vermi-compost their preparation, characteristics and preservation. Bio-fertilizers and their role in crop production. Biodegradation of pesticides; microbial toxins in soil.

A. Lectures

S.N.	Topic	No. of lectures
1.	Introduction to soil biota; soil microbial ecology. Microorganisms in soil- their growth & interactions.	4
2.	Soil microbial biomass: importance and unculturable soil biota.	2
3.	Biotic factors in soil development and; soil characteristics influencing growth & activity of micro-flora	3
4.	Microbiology and biochemistry of rhizosphere and phyllosphere.	3
5.	Soil enzymes: Origin, classification, importance and their activities.	3
6.	Role of microbes in biogeochemical cycles in soil: Nitrogen-biological Nitrogen fixation-symbiotic, asymbiotic; mechanism of biological nitrogen fixation & factors influencing; nitrification, denitrification; Phosphorus-solubilization by solubilizing microbes; sulphur, iron, and manganese.	5
7.	Soil organic matter & crop residue: Biochemical composition and degradation; humus formation.	4
8.	Biochemistry and microbiology of biogas production from organic wastes	2
9.	Organic manures: farm yard manure, urban & rural composts, enriched compost, vermi-compost: process, characteristics and governing factors.	3
10.	Biofertilizers-status, types, challenges and their role in crop production.	3
11.	Biodegradation of pesticides, microbial toxins	2
	Hourlies	2
	Total	**36**

B. Practicals

S.N.	Topic	No. of practicals
1.	Determination of soil microbial population (bacteria, fungi, actinomycetes and blue green algae)	3
2.	Study of rhizosphere effect	1
3.	Estimation of soil microbial biomass	2
4.	Study of organic matter decomposition in soil	2
5.	Estimation of dehydrogenase activity in soil	2
6.	Study of methods of estimation of biological nitrogen fixation	1
7.	Study of mineralization process during organic matter decomposition	2
8.	Determination of p-solubilization efficiency of p-solubilizing microorganism	2
9.	Fractionation of organic matter & functional groups	2
	Final Practical	1
	Total	**18**

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.

Burges A & Raw F. 1967. *Soil Biology.* Academic Press.

McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.

Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.

Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.

Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.

Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill.

Stotzky G & Bollag JM. 1993. *Soil Biochemistry*. Vol. VIII. Marcel Dekker.

Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.

Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SEMESTER II

Course Title : **Advances in Soil Physics**
Course No. : **SDSU-201**
Credit Hours : **2(2-0-0)**
Pre-requisite : **Soil Physics (APS-500)**

Syllabus

Statistics and dynamics of soil water, air and heat in soil, water and salt transport in soil, soil crusting and clodding properties, solar and terrestrial radiation, aero-dynamic properties and canopy temperature models in agriculture..

Lectures

S.No.	Lectures topic	Cr.hr.
1.	Soil-Water : interaction, soil water potential, free energy and thermodynamics basis of potential concept, chemical potential of soil water and entropy of the system	5
2.	Fundamentals of fluid flow : Poisecuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity, limitations of Darcy's law; numerical solution for one dimensional water flow	6
3.	Theories of horizontal and vertical infiltration under different boundary conditions	5
4.	Movement of salts in soils, models for miscible, immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves.	5
5.	Soil and aerations, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.	5
6.	Soil crust and clod formation, structural management of puddle rice soils, soil conditioning, concept soils conditioners – types,	4
7.	characteristics working principles, significance in agriculture. Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop system, prediction of evapotranspiration using aerodynamic and canopy temperature based models, canopy temperature and leaf diffusion resistance in relation to plant water deficit, evaluation of soil and plant water status using infra-red thermometer.	6
	Hourlies	02
	Total	**38**

References book :

1. Baver, L.D. Gardner, W.H. & Gardner, W.R. 1972. *Soil Physics*. John Wiley & Sons.
2. Hanks and Ascheroft. 1980. *Applied Soil Physics*. Sprintger Verlag.
3. Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
4. Hillel D. 1980. *Environmental Soil Physics*. Academic Press.
5. Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
6. Kirkham, D. & Power, W.L. 1972. *Advanced Soil Physics*. Wiley Interscience.
7. Lal, R, & Shukla, M.K. 2004. *Principles of Soil Physics*. Marcel Dekker.
8. Iswal, M.C. 1994. *Soil Physics*. Oxford & IBH.

Course Title : **Analytical Techniques and Instrumental methods in Soil and Plant analysis**
Course No. : **SDSU-202**
Credit Hours : **2 (0-0-2x3)**

Syllabus

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling. Estimation of phosphorus, ammonium and potassium fixation capacities of soils. Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques. Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo. Analysis of plant materials by digesting plant materials by wet and dry ashing and of soil by wet digestion method.

Practicals

Sl. No	Topic	No. of Practicals
1.	Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidationreduction and complexometric titration;	4
2.	Soil, water and plant sampling techniques, their processing and handling.	2
3.	Estimation of phosphorus, ammonium and potassium fixation capacities of soils.	3
4.	Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry.	5
5.	Chromatographic techniques	3
6.	Electrochemical titration of clays.	2
7.	Estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.	3
8.	Analysis of soil for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo.	8
9.	Analysis of plant materials by digesting plant materials by wet and dry ashing methods	5
	Practical Final	01
	Total	**36**

References:

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.
Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
Piper CE. *Soil and Plant Analysis*. Hans Publ.
Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*. IARI, New Delhi.
Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

Course title : Soil Fertility and Fertilizer Use
Course No. : SDSU-203,
Credit hr. : 4(3-0-1x3)

Syllabus

Soil fertility; plant growth and nutrition; Nutrient sources; Essential plant nutrients; Multiple nutrient deficiency; Sources forms and transformation of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients; Dynamics of major nutrient; Fate of applied nutrient in soil their interaction with organic and inorganic constituents; Losses, fixation and availability of nutrients to plants; Nutrient management under various soil, crop and climatic conditions; Efficient nutrient management for sustainable high productivity; Soil fertility, mapping using GIS, GPS.

A. Lectures

Sl.No.	Lecture topic	Cr.hr.
1.	Soil fertility and productivity; Plant growth and nutrition; nutrient sources – fertilizers and manures	2
2.	Soil and fertilizer nitrogen – gain and losses of nitrogen; sources, forms, immobilization and mineralization, nitrification, denitrification biological nitrogen fixation – types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency; nitrogen balance sheet	10
3.	Soil and fertilizer phosphorus – forms immobilization, mineralization reactions in acid and alkali soils, factors affecting phosphorus availability in soils; P-fixation mechanism; phosphatic fertilizers – behaviour in soils and management under field conditions.	7
4.	Potassium – forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.	7
5.	Sulphur – source, forms, fertilizers and their behaviour in soils; calcium and magnesium – factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.	5
6.	Micronutrients in soil, plant, animal and human health – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.	5
7.	Common soil test methods for fertilizer recommendations; quantity – intensity relationships; soil test crop response correlations and response function; use of isotopes in soil fertility research	2
8.	Nutrient management under various soil, crop and climatic conditions – acid soils, dry lands, cold regions, horticultural crops, plantation crops	5
9.	Efficient nutrient management for sustaining high productivity –soil quality, Improved agronomic practices, balance use of fertilizer, INM, soil test based fertilizer recommendation, site specific nutrient management	2
10	Soil fertility mapping using GIS & GPS for on line fertilizer recommendation	2
11	Fertilizer use efficiency; usefulness and limitations, Use of customized and value added fertilizer	2

	Hourlies Exam.	02
	Total	**51**

B. Practicals

Sl.No.	Lab. topic	Cr.hr.
1.	Determination of total nitrogen in soil	1
2.	Determination of total phosphorus in soil	1
3.	Determination of total potassium in soil	1
4.	Determination of total sulphur in soil	1
5.	Availability indices of nitrogen in soil particularly multi nutrient extractant	2
6.	Availability indices of phosphorus in soil particularly multi nutrient extractant	2
7.	Availability indices of potassium in soil particularly multi nutrient extractant	2
8.	Availability indices of sulphur in soil particularly multi nutrient extractant	2
9.	Availability indices of micronutrient in soil particularly multi nutreitn extractant	3
10.	Determination of total nutrient content in plant samples	2
		17
	Lab. Final Exam.	01
	Total	**18**

References:

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ. Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.

Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality*. 2nd Ed. CRC Press.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 2007. *Soil Fertility and Fertilizers*. 7th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

ISSS. 2009. Indian Society of Soil Science (2nd Ed.). ISSS, New Delhi.

Singh, Dhyan; Chhonkar, P.K. and Dwivedi, BS. (2005) *Manual on Soil, Plant and Water Analysis*. Westville Publishing House, New Delhi.

Course Title : Management of Problem Soils and Waters
Course No. : SDSU-204,
Credit Hours : 3 (2-0-1)

Syllabus

To educate students about basic concepts of problem soils, formation and basic characteristics; Use of saline water, brackish water and their management. Studies on salt tolerant crops Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Lectures

S.No.	Titles of outlines	lectures
1.	Introduction	
	(a) Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils;	1
	(b) Origin and basic concept of problematic soils, and factors responsible	2
2.	Characterization	
	(a) Morphological features of saline, sodic and saline-sodic soils	3
	(b) Characterization of salt-affected soils - soluble salts, ESP, pH, physical, chemical and microbiological properties	4
3.	Management of salt affected soils	
	(a) Management of salt-affected soils; salt tolerance of crops mechanism and ratings;	3
	(b) Monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils	3
4.	Soil Acidity	
	(a) Acid soils - nature of soil acidity, sources of soil acidity; Effect on plant growth,	2
	(b) Lime requirement of acid soils; management of acid soils, biological sickness of soils and its management	3
5.	The quality of irrigation water	
	(a) Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation	3
	(c) Characterization of brackish waters, area and extent; relationship in water use and quality	3
6.	Agricultural management	
	(a) Agronomic practices in relation to problematic soils	1
	(b) Cropping pattern for utilizing poor quality ground waters.	1
	Hourlies	02
	Total	**29**

Practicals

S.No	Titles	No of lectures
1.	**Characterization of acid, acid sulfate, salt-affected and calcareous soils** .	
	(a) Determination of Carbonate and Bicarbonate in soil and water	2
	(b) Determination of Sulphate in soil and water	1
	(c) Determination of Chloride in soil and water	1
	(d) Determination of Total soluble salts	1
	(e) Determination of pH and EC of Saturation extract	1
	(f) Determination of CEC and Ex. cations	1
2.	**Determination of anions (Cl^-, SO_4^{--}, CO_3^{--} and HCO_3^-) in ground waters and soil samples and (Na+, K+, Ca++ and Mg++) in ground water and soil samples**	
	(a) Determination of ESP and SAR	2
	(b) Determination of RSC	1
	(c) Determination of Exchangeable H^+ and Al^+ in soil	1
3.	**Lime and gypsum requirements of acid and sodic soils**	
	(a) Determination of Lime requirement of soils	1
	(b) Determination of Gypsum requirement of soils	1
	Final practical	1
	Total	**14**

Suggested Readings

Bear FE. (1964) Chemistry of the Soil. Oxford & IBH.

Jurinak JJ.(1978) Salt-affected Soils. Department of Soil Science &Biometeorology. Utah State Univ.

USDA Handbook No. 60. (1954) Diagnosis and improvement of Saline and Alkali Soils. Oxford & IBH.

K.V.Paliwal (1972) Irrigation with saline water, ICAR.

Tanjr (ed) (1995) Agril Salinity Assessment and Management. Sci. Pub. Jodhpur,1995

Mohisin, Sarkar and Mathur(eds) (1995) Acid Soil Management. Kalyani Publishers

SEMESTER -III

Course Title : Fertilizer Technology
Course No. : SDSU-301,
Credit Hours : 1 (1-0-0)

Syllabus

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

Lectures

S.No	lectures	No of lectures
1.	Fertilizers production, consumption and future projections with regard to nutrient use in the country and respective states	2
2	Introduction of Fertilizer Control Order.	2
3.	Manufacturing processes for different fertilizers using various raw materials	3
4.	Characteristics and nutrient contents in various raw materials	2
5.	Recent developments in secondary and micronutrient fertilizers	1
6.	Quality control of fertilizers as per Fertilizer Control Order 99	2
7.	New and emerging issues in fertilizer technology – production and use of slow and controlled release fertilizers, super granules fertilizers	2
8.	Fertilizers for specific crops / situations.	1
	Hourlies	2
	Total	**17**

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.

Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI New Delhi.

Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.

Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technologyand Use*. 2nd Ed. Soil Sci. Soc. Am. Madison.

Prasad R & Power JF. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* McMillan Publ.

Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

3rd Semester
Course Title : Land degradation and Restoration
Course No. : SDSU-302,
Credit Hours : 1 (1-0-0)

Syllabus

To impart knowledge related to various factors and processes of land degradation and their restoration techniques; modern tools and techniques for assessment of land degradations; policies in relation to land use and global issues of degradation

Lectures

S.No	Lectures topics	No. of Lectures
1.	Type, factors and processes of soil/land degradation	2
2.	Impact land Degradation on soil productivity, including soil fauna, biodegradation and environment	3
3.	Land restoration and conservation techniques – erosion control soil and water	2
4.	Reclamation of salt-affected soils; mine land reclamation, afforestation, organic products	3
5.	Extent, diagnosis and mapping of land degradation by conventional methods	1
6.	Modern RS-GIS tools; monitoring of land degradation by fast assessment modern tools	2
7.	Land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.	2
	Hourlies	2
	Total	**17**

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.). 1996. Soil Management in Relationto Land Degradation and Environment. Bull. Indian Soc. Soil Sci.17, New Delhi.

Doran JW & Jones AJ. 1996. Methods of Assessing Soil Quality. SoilScience Society of America,

Madison. Greenland DJ & Szabolcs I. 1994. Soil Resilience and Sustainable Land Use. CABI.

Course Title : **Remote Sensing and GIS Techniques for Soil, Water and Crop Studies.**
Course No. : **SDSU-303**
Credit Hours : **3(2-0-1x 3)**

Syllabus

To impart knowledge about the basic concepts of remote sensing, aerial photographs and imageries and their interpretation, application of remote sensing in general and with special reference to soil, plants and yield forecasting; to impart knowledge about geo-statistical techniques with special reference to Krigging and GIS and applications in agriculture.

A. Lectures

S.No.	Lectures topic	Cr.hr.
1.	Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter	4
2.	Sensor systems – camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations	4
3.	Application of remote sensing techniques – land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management	4
4.	Significance and sources of the spatial and temporal variability in soils ; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability	4
5.	Introduction to GIS and its application for spatial and non-spatial soil and land attributes	18
	Total	34
	Hourly Examination	02
	Total	**36**

B. Practical:

S.No.	Topic	No. of practical
1.	Familiarization with different remote sensing equipments and data products	1
2.	Interpretation of aerial photographs and satellite data for mapping of land resources	3
3.	Analysis of variability of different soil properties with classical and geo-statistical techniques	2
4.	Creation of data files in a database programme	3
5.	Use of GIS for soil spatial simulation and analysis	5
6.	To enable the students to conduct soil survey and interpret soil survey	2
	Total	16
	Practical Final Exam.	01
	Total	**17**

Course Title : **Advances in Soil Fertility**
Course No : **SDSU-304,**
Credit Hours : **2(2-0-0)**

Syllabus

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices. Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils. Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils. Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting. Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture. Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Lectures

Sl. No	Topic	No. of Lectures
1	Introduction to modern concepts of nutrient availability.	1
	Soil solution and plant growth.	1
2	Nutrient response functions and availability indices.	2
3	Nutrient movement in soils; nutrient absorption by plants.	3
4	Mechanistic approach to nutrient supply and uptake by plants.	2
5	Models for transformation and movement of major micronutrients in soils.	2
6	Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.	3
7	Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.	2
8	Modern concepts in fertilizer application.	2
9	Soil fertility evaluation techniques.	2
10	Role of soil tests in fertilizer use recommendations.	3
11	Site-specific nutrient management for precision agriculture.	2
12	Monitoring physical, chemical and biological changes in soils.	3
13	Permanent manurial trials and long-term fertilizer experiments.	2
14	Soil productivity under long-term intensive cropping.	3
1. 14	Direct, residual and cumulative effect of fertilizer use.	3
	Hourlies	02
	Total	**38**

SEMESTER -IV

Course title : Biochemistry of Soil Organic Matter
Course No. : SDSU-401,
Credit Hrs. : 2(2-0-0)
Syllabus

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools. Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids. Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils. Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes. Humus - pesticide interactions in soil, mechanisms. Use of ^{14}C in sol organic matter studies. Ecosystem management and soil organic matter.

Lectures

S.N.	Topic	No. of lectures
1.	Soil organic matter: pools, forms, composition, distribution, importance and functions in soil	4
2.	Decomposition of organic residues in soil in relation to organic matter pools. Microbiology and biochemistry of different components of organic residues and; organic matter stability	5
3.	Formation of humic and fulvic acids and their decomposition	3
4.	Biochemistry of humus formation: different pathways of humus synthesis and environmental significance of humic substances. Non humic substances in soil-carbohydrates and lipids	3
5.	Soil organic matter as plant nutrient reservoir: – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils	4
6.	Reactive functional groups of humic substances, adsorption of organic compounds by clay	2
7.	Biological reactions during soil organic matter transformation contributing to soil structural development	1
8.	Role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes	3
9.	Humification of pesticides and mechanisms involved	2
10.	Use of ^{14}C in sol organic matter studies.	2
11.	Impact of ecosystem disruption and agricultural soils	2
12.	Management of soils for optimal organic matter accumulation	2

Hourlies	2
Total	**35**

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic *Substances in Soil and Water: Natural Constituents and their Influences* on Contaminant Behavior. Royal Society of Chemistry, London.

Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components*. Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. Organic Agriculture: *A Global Perspective*. CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture*. John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions*. John Wiley & Sons.

Course title : **Basic Staticics**
Course No. : **SDSU-402,**
Credit Hrs. : **2(2-0-0)**

Syllabus

Analysis of variance: Definition and assumptions, one way classification, two way classification. Sampling Techniques: Simple random sampling, stratified random sampling, systematic sampling. Design Experiments: Randomized Block design, Latin Square design, Factorial design (22, 23, 32, 33 factorials), Some P x Q experiments, Split Plot Experiments. Balanced Incomplete Block design.Statistical Methods: Measures of Skewness and Kurtosis, standard error of mean, Coefficient of variation. Theory of Probability : Definitions, Additions and Multiplication rules of Probability, Conditional Probability. Probability distributions: Normal, Binomial and Poisson distributions. Correlation and Regression : Simple correlation, Rank correlation, Regression Coefficient, Multiple and Partial Correlation, Regression lines between two variables, Multiple Regression. Tests of Significance: X2 - test, t - test one sample, two sample t – tests, paired t-test, F – test, Fisher's 2 – transformation.

M.Sc. (AGRICULTURE) SOIL SCIENCE
FOURTH SEMESTER
COURSE CONTENTS – DETAILED SYLLABUS
PAPER – 403: SEMINAR

M.Sc. (AGRICULTURE) SOIL SCIENCE
FOURTH SEMESTER
PAPER – 404: THESIS (THESIS & VIVA-VOCE) at least 3 month

M.Sc. (AGRICULTURE) SOIL SCIENCE
FOURTH SEMESTER
PAPER – 405
PRACTICAL
SOIL SCIENCE