Department of Soil Science and Agricultural Chemistry
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Master's Programme in Soil Science and Agricultural Chemistry

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	20
2.	Minor	09
3.	Supporting	05
4.	Seminar	01
5.	Research	20
	Total Credits	**55**
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min. 21 credits)			
	SOILS -501	Soil Physics	2+1=3
	SOILS -502	Soil Fertility and Fertilizer Use	3+1=4
	SOILS -503	Soil Chemistry	2+1=3
	SOILS -504	Soil Mineralogy, Genesis Classification and Survey	2+1=3
	SOILS -506	Soil Biology and Biochemistry	2+1=3
	SOILS-511	Analytical Techniques and Instrumental Methods in Soil and Plant Analysis	0+2=2
	SOILS -513	Management of Problematic Soils and Water	2+1=3

B) Minor Subjects (Min. 09 credits)			
	SOILS -509	Soil, Water and Air Pollution	2+1=3
	BIOCHEM-501	Basic Biochemistry	2+1=3
	AGRON-505	Agro Meteorology and Crop Weather Forecasting	2+1=3
C) Supporting Subjects (Min. 05 credits)			
	PP-511	Mineral Nutrition	2+1=3
	STAT-512	Experimental Design	2+1=3
D) Seminar (1 credit)			
	SOILS-591	Master Seminar	0+1=1
E) Master's Research (20 credits)			
		Master's Research	0+20=20
F) Non Credit Compulsory Courses			
	PGS-501	Library and Information Services	0+1=1
	PGS-502	Technical Writing and Communications Skills	0+1=1
	PGS-503	Intellectual Property and its Management in Agriculture	1+0 =1
	PGS-504	Basic Concepts in Laboratory Techniques	0+1=1
	PGS-505	Agriculture Research, Research Ethics and Rural Development Programmes	1+0 =1
	PGS-506	Disaster Management	1+0=1

Course Contents

Course Title : SOIL PHYSICS
Course No. : SOILS – 501 2+1=3

Syllabus

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface

UNIT IV

Soil structure – genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting – mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties, clod formation.

UNIT V

Soil water content and potential, soil water retention, soil water constants, measurement of soil water content, energy state of soil water, soil water potential, soil moisture characteristic curve, hysteresis, measurement of soil moisture potential.

UNIT VI

Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity, measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT VII

Infiltration, internal drainage and redistribution; evaporation, hydrologic cycle, field water balance, soil plant atmosphere continuum.

UNIT IX

Composition of soil air, renewal of soil air – convective flow and diffusion; measurement of soil aeration requirement for plant growth, soil air management

UNIT X

Modes of energy transfer in soils, energy balance, thermal properties of soil, measurement of soil temperature, soil temperature in relation to plant growth, soil temperature management.

Practical

- Mechanical analysis by international pipette and hydrometer methods
- Measurement of Atterbergs limits
- Aggregate analysis-dry and wet
- Measurement of soil water content by different methods
- Measurement of soil water potential by using tensiometer and gypsum blocks

- Determination of soil moisture characteristics curve and computation of pore size distribution
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of aeration porosity and oxygen diffusion rate
- Soil temperature measurements by different methods
- Estimation of water balance components in bare and cropped fields

Suggested Readings:

Baver L. D., Gardner W. H. and Gardner W. R. 1972. *Soil Physics*. John Wiley and Sons.

Ghildyal, B. P. and Tripathi, R. P. 2001. Soil Physics. New Age International.

Hanks, J. R. and Ashcroft, G. L. 1980. Applied Soil Physics. Springer Verlag.

Hillel, D. 1972. Optimizing the Soil Physical Environment towards Greater Crop Yields. Academic Press.

Hillel, D. 1980. Application of Soil Physics. Academic Press.

Hillel, D. 1980. Fundamentals of Soil Physics. Academic Press.

Hillel, D. 1998. Environmental of Soil Physics. Academic Press.

Hillel, D. 2003. Introduction to Environmental Soil Physics. Academic Press.

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

Kirkham, D. and Powers, W. L. 1972. Advanced Soil Physics. Wiley Interscience.

Kohnke, H. 1968. Soil Physics. McGraw Hill.

Lal, R. and Shukla, M. K. 2004. Principles of Soil Physics. Marcel Dekker.

Oswal, M. C. 1994. Soil Physics. Oxford and IBH.

Saha, A. K. 2004. Text Book of Soil Physics. Kalyani.

Course Title: SOIL PHYSICS

Course No. SOILS 501 2+1=3

Theory:

Sr. No.	Lecture No.	Topics to be covered	Weightage in marks
1	1	Scope of soil physics and its relation with other branches of soil science	2
2	2	Soil as a three phase system, mass volume relationship	3
3	3, 4	Soil texture, textural class, particle size distribution, Stoke's law, specific surface	5
4	5, 6, 7	Soil consistence, dispersion and workability of soil, soil compaction and consolidation, soil strength, swelling and shrinkage basic concept	5
5	8, 9	Soil texture, genesis, types, characterization and management of soil structure, soil aggregation, aggregate stability, characteristics of good soil tilth	5
6	10, 11	Soil crusting, mechanism, factor affecting and evaluation, soil conditioner, puddling its effect on soil physical properties, clod formation	5
7	12, 13	Soil water content and potential, soil water retention, soil water constant	5
8	14, 15, 16	Measurement of soil water content, energy state of soil water, soil water potential	5
9	17, 18	Soil moisture characteristics curve, hysterysis measurement of soil water potential	5
		Mid Term	
10	19	Water flow in saturated and unsaturated soil	3
11	20	Poiseuille's law, Darcy's law, hydraulic conductivity	3
12	21	Permeability and fluidity, hydraulic diffusivity	3
13	22	Measurement of hydraulic conductivity in saturated and unsaturated soil	3
14	23	Infiltration, internal drainage and redistribution	3
15	24	Soil water losses, evaporation, percolation, leaching	2
16	25, 26	Hydrologic cycle, field water balance soil plant atmosphere continuum	5
17	27, 28	Composition of soil air, renewal of soil air convective flow and diffusion	3
18	29, 30	Measurement of soil aeration, aeration requirement for plant growth, soil air management	5
19	31, 32,	Soil temperature, thermal properties of soil thermal	5

	33	conductivity, diffusivity, specific heat capacity, heat transfer in soil, Fourier law of heat conductivity	
20	34, 35, 36	Mode of energy transfer in soil energy balance variation in soil temperature, factors affecting soil temperature, measurement of soil temperature modification of temperature	5

Practical:

Sr. No.	Exercise No.	Topics to be covered
1	1-2	Mechanical analysis by international pipette and hydrometer method
2	3	Determination of soil consistence by Atterberg limits
3	4	Water stable aggregate analysis by wet sieving method (Yoder's apparatus)
4	5-6	Determination of soil moisture content by Direct method-gravimetric
5	7	Determination of soil moisture content by indirect method. Neutron moisture meter, Gypsum block
6	8-9	Determination of soil moisture characteristics curve by pressure plate apparatus for coarse and fine textured soil
7	10	Determination of soil moisture tension by tensiometer method
8	11	Determination of bulk density : core and Clod method
9	12	Determination of crust strength by modules of rapture or penetrometer
10	13	Determination of macro and micro porosity
11	14	Determination of hydraulic conductivity under saturated and unsaturated condition
12	15	Determination of infiltration rate by double ring infiltrometer
13	16	Determination of oxygen diffusion rate by platinum electrode method
14	17	Determination of soil temperature and thermal conductivity by thermocouple thermostat
15	18	Estimation of water balance component in base and cropped field

Course Title : SOIL FERTILITY AND FERTILIZER USE

Course No. : SOILS – 502 3+1

Syllabus

UNIT I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures, essential plant nutrients, functions and deficiency symptoms.

UNIT II

Soil and fertilizer 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.

UNIT III

Soil and fertilizer phosphorus – forms, immobilization, mineralization, reactions in acid and alkali soils, factors affecting phosphorus availability in soils, phosphatic fertilizers – behavior in soils and management under field conditions.

UNIT IV

Potassium – forms, equilibrium in soils and its agricultural significance mechanism of potassium fixation, management of potassium fertilizers under field conditions.

UNIT V

Sulphur – source, forms, fertilizers and their behavior in soils, calcium and magnesium – factors affecting their availability in soils, management of sulphur, calcium and magnesium fertilizers.

UNIT VI

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability

UNIT VII

Common soil test methods for fertilizer recommendations; quantity/intensity relationships; soil test crop response correlations and response functions.

UNIT VIII

Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site specific nutrient management; plant need based nutrient management; integrated nutrient management.

UNIT IX

Soil fertility evaluation – biological methods, soil, plant and tissue tests, soil quality in relation to sustainable agriculture.

Practical

- Principles of colorimetry
- Flame photometry and atomic absorption spectroscopy
- Chemical analysis of soil for total and available nutrients
- Analysis of plants for essential elements

Suggested Readings

Brady N. C. and Weil R. R. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.

Kabata – Pendias A and Pendias H. 1992. Trace Elements in Soils and Plants. CRC Press.

Kannaiyan, S. Kumar K. and Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.

Leigh J. G. 2002. Nitrogen Fixation at the Millennium. Elsevier.

Mengel K. and Kirkby E. A. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland.

Mortvedt J. J., Shuman L. M. Cox F. R. and Welch R. M. 1991. Micronutrients in Agriculture. 2nd Ed. SSSA, Madison.

Pierzinsky, G. M., Sims T. J. and Vance J. F. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press.

Stevenson F. J. and Cole M. A. 1999. Cycles of Soil Carbon, Nitrogen, Phosphorus, Sulphur, Micronutreints. John Wiley and Sons.

Tisdale, S. L., Nelson S. L., Beaton J. D. and Havlin J. L. 1999. Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.

Troeh F. R. and Thompson L. M. 2005. Soils and Soil Fertility. Blackwell.

Course Title: SOIL FERTILITY AND FERTILIZER USE

Course No. SOILS 502 3+1=4

Theory:

Sr. No.	Lecture No.	Topics to be covered	Weightage in marks
1	1	Soil fertility and soil productivity	3
2	2 , 3	Nutrient sources- fertilizers and manures	3
3	4-5	Essential plant nutrients- classification and essentiality criterion of nutrients. Forms absorbed by plants	5
4	6-8	Functions and deficiency symptoms of primary and secondary nutrients	5
5	9-11	Functions and deficiency symptoms of micronutrients nutrients	5
6	12-13	Sources and forms of nitrogen in soils – immobilization and mineralization (nitrification, denitrification,)	5
7	14-15	Biological N fixation Factors affecting N fixation,	5
8	16-17	Nitrogen fertilizers, their classification and fertilizer N management in Low land upland conditions, fertilizer N use efficiency	5
9	18	Soil fertilizer Phosphorus – forms of soil P , immobilization and mineralization of soil P	3
10	19	Factors affecting the P availability in soil	3
11	20-21-22	Phosphatic fertilizers, their classification and behaviour and management of P fertilizers under field conditions.	5
12	23-24	Forms of potassium in soil, factors affecting K availability (soil and plant factors)	5
13	25-26	K fixation factors affecting it	5
14	27-28	K fertilizers and their classification and management of K fertilizers under field conditions	5
15	29	Sulphur- forms , and sources of S in soils, S behavior in soils	2
16	30	Sulphour fertilizers and their behaviour in soils	3
17	31	Calcium and magnesium- forms , and sources of Ca & Mg in soils, Ca & Mg behavior in soils	3
18	32	Calcium and magnesium fertilizers and their behavior in soils	3
19	33-34	Micronutrients – critical limits in soil and plants, micronutrient availability in soil and factors affecting it.	5
20	35-36	Deficiency symptoms and their corrections in plants.	5

21	37	Role of chelates in nutrient availability	3
22	38-39-40	Common soil test methods for fertilizer recommendations	5
23	41-42	Quantity /intensity of phosphorus and potassium, STCRC,	5
24	43	Response functions	3
25	44-46	Fertilizer use efficiency – blanket fertilizer recommendations – their usefulness and limitations., site specific nutrient management and plant need based nutrient management	5
26	47-48	Integrated nutrient management – components and their beneficial effects	5
27	49-50	Soil fertility evaluation - classification	3
28	51-52	Soil and plant tissue test	4
29	53-54	Soil quality to sustainable agriculture	4

Practical:

Sr. No.	Exercise No.	Topics to be covered
1	1	Principles of colourimetry
2	2	Principles of flame photometry
3	3	Principles of atomic absorption spectrophotometry
4	4	Determination of available nitrogen
5	5	Determination of ammonical and nitrate nitrogen
6	6	Determination of available phosphorus
7	7	Determination of available potassium
8	8	Determination of exchangeable cations
9	9	Determination of available S
10	10	Determination of DTPA- Fe , Mn, Zn and Cu from soil
11	11	Determination of available B
12	12	Determination of available Mo
13	13	Preparation of an acid extract
14	14	Determination of total nitrogen in plants
15	15	Determination of P in plants
16	16	Determination of total K in plants
17	17	Determination of S in plants
18	18	Determination of micronutrients in plants

Course Title : SOIL CHEMISTRY

Course No. : SOILS – 503 2+1

Syllabus:

UNIT I

Chemical (elemental) composition of the earth's crust and soils.

UNIT II

Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT III

Soil colloids : 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, 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.

UNIT IV

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.

UNIT V

Potassium, phosphate and ammonium fixation in soils covering specific and non specific sorption; precipitation dissolution equilibrium; step and constant rate K; management aspects.

UNIT VI

Chemistry of acid soils, active and potential acidity; lime potential, chemistry of acid soils; sub soil acidity.

UNIT VII

Chemistry of salt affected soils and amendments; soil, pH, EC, ESP, SAR and important relations; soil management and amendments.

UNIT VIII

Chemistry and electrochemistry of submerged soils.

Practical:

- Determination of CEC and AEC of soils.
- Analysis of equilibrium soil solution for pH, EC, E_h by use of E_h-pH meter and conductivity meter.
- Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometer titration method.
- Potentiometric and condcutometeric titration of soil humic and fulvic acids.
- (E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the (E_4/E_6) values at two pH values.
- Adsorption- desorption of phosphate/sulphate by soil using simple adsorption isotherm.
- Construction of adsorption envelope of soils by using phosphate/fluoride / sulphate and ascertating the mechanism of the ligand exchange process involved.
- Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method.
- Determination of lime requirement of an acid soil by buffer method.
- Determination of gypsum requirement of an alkali soil.

Suggested Readings:

Bear RE. 1964. *Chemistry of the soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry* . Elsevier.

Greenland DJ & Hayes MHB/ 1981. *Chemistry of Soil Processes.* John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils*. Oxford Univ. Press

Sposito G. 1981. *The Thermodynamics of Soil Solutions.* Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils.* Oxford univ. Press.

Sposito G. 1989. *The Chemistry of Soils.* Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry* . 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry.* John Wiley & Sons.

Course Title : SOIL CHEMISTRY

Course No. : SOILS – 503 2 + 1

Theory:

Sr. No.	Topic	Weightage in marks
1-2	Chemical (elemental) composition of the earth's crust and soils	4
3-6	Elements of equilibrium, soil chemical equilibrium, chemical and SI units, solute intraction, ion activity, activity coefficient, complex ion and ion pairs, hydrolysis and deprotonation, acids and bases, solubility product, soil reaction coefficient., low of mass action, soil solution, chemical equilibria, electrochemistry, thermodynamics and chemical kinetics, reaction order rate constant, factors affecting rates of reactions, microbes , catalysis	8
7-9	Soil colloids : inorganic and organic colloids-origin of change, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils, classification structure transformation and properties of inorganic colloids.	6
10-12	Diffuse double layer theories of soil colloids, zeta potential, stability, coagulation /flocculation and peptization of soil colloids, ion retension mechanisom, electromectric properties of soil.	6
13-15	Soil organic matter, characterision -fractionation of soil organic matter organic components, carbohydrates, proteins, amino acids, lipids, Types of humic substances, lignin, humas, spectral characteristics, structural chemistry of humic substances, different fractions, clay-organic interactions	6
16-18	Ion exchange processes in soil; Historical background, CEC models based on thermodynamic cation exchange-theories based on low of mass action (Kerr-Vanselow, Erikson, Gapon equations, hysteresis, Jenny's concept), factors affecting CEC.	6
19-21	Adsorption isotherms, donnan-membrance equilibrium concept, clay membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics;.	6
22-24	Anion and ligand exchange-inner-sphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions, shift of PZC on ligand exchange, AEC, CEC .	8
25-26	Experimental methods to study ion exchange phenomena and practical implications in plant nutrition	6
	Potassium, phosphate and ammonium fixation in soils covering	8

27-30	specific and non specific sorption; precipitation-dissolution equilibra; step and constant rate K; management aspects	
31-32	Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid sols; sub-soil acidity. Electro-chemical changes occurring in submerged soil. Nutrient transformation in acid soils. Redox potential, Eh-pH diagram, management of acid soils.	6
33-35	Chemistry of salt affected soils and amendments; soil pH, ECe, ESP, SAR and important relations; soil management and amendments, reclamation of salt affected soils. Mechanical, chemical, hydralogical and biological reclamation	8
36	Chemistry and electrochemistry of submerged soils	2

Practical:

Practical No.	
1-2	Determination of CEC and AEC of soils.
3	Analysis of equilibrium soil solution for pH, EC, E_h by use of E_h-pH meter and conductivity meter.
4-5	Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometer titration method.
6-7	Potentiometer and condcutometeric titration of soil humic and fulvic acids.
7-8	(E_4/E_6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the (E_4/E_6) values at two pH values.
9-10	Adsorption- desorption of phosphate/sulphate by soil using simple adsorption isotherm.
11-12	Construction of adsorption envelope of soils by using phosphate/fluoride / sulphate and ascertaining the mechanism of the ligand exchange process involved.
13-14	Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method.
15-16	Determination of lime requirement of an acid soil by buffer method.
17-18	Determination of gypsum requirement of an alkali soil.

Course Title: SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY

Course No. SOILS-504 2+1=3

Syllabus:

UNIT I

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism.

UNIT II

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.

UNIT III

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.

UNIT IV

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.

UNIT V

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.

UNIT VI

Landform – soil relationship major soil groups of India with special reference to respective states, land capability classification and land irritability classification land evaluation and land use type (LUT) – concept and application approaches for managing soils and landscapes in the framework of agro ecosystem.

Practical:

- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different landforms
- Classification of soils using soil taxonomy
- Calculation of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soils using available data base in terms of soil quality
- Aerial photo and satellite data interpretation for soil and land use

- Cartographic techniques for preparation of base maps and thematic maps processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercise using conventional and RS tools.

Suggested Readings:

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

Buol EW, Hole ED, Mac Cracken 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

Grim RE. 1968. Clay Mineralogy, 2nd Edn. McGraw Hill, New York

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

Sehgal, J. 1986. Introductory Pedology : Soil Genesis, Survey and Classification, Kalyani Publ., New Delhi.

Sehgal, J. 2002. Pedology-Concepts and Applications, Kalyani Publ., New Delhi, 485p.

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 MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY

Course No. SOILS-504 **2+1=3**

Theory:

Unit No.	L. No.	Topic	Weightage in marks
1	1	Soil mineralogy, Definition and Significance	2
2	2-3	Fundamentals of crystallography, crystal chemistry, bonding forces, co-ordination principle, radius ratio, pauling rule, co-ordinatin rule, isomorphism and polymorphism	4
3	4	Classification of mineral, mode of formation, sp. Gravity, chemical composition and quality	3
4	5	Classification based on tetrahedral linkages and non silicate minerals	2
5	6	Structure of mineral, tetrahedral and octahedral unit, types of tetra and octahedral sheets, layer charge and polytypes	4
6	7-8	Types of clay minerals, 1:1, 2:1 and 2:1:1 mineral and its properties	4
7	9	Genesis and transformation of crystalline and non crystalline clay minerals	3
8	10-11	Identification of clay minerals in Indian soil by using advance methods (XRD, SEM, TEM, IR, DTA etc)	4
9	12-13	Weathering of rocks and minerals and different types of weathering	4
10	14	Goldich and jacksons stability series of crystalline minerals	2
11	15-17	Soil formation and factors of soil formation. Soil forming processes	4
12	18	Soil profile and master and Subsurface horizon	3
13	19	Soil individual and its concept, soil classification, earlier system of classification economical, physical, chemical, geological and physiographic	3
14	20	Mid semester	
15	21	Recent advances system of soil classification – Dokuchaev's zonality concept, Coffey's system, Marbut's morphogenic system, Baldwin, kellog and Throps genetic system	3

16	22-23	Soil taxonomy, development, structure and salient features of soil taxonomy, soil orders	4
17	24	Diagnostic horizons, Epipedon, endopedon, other diagnostic features, differentiating properties of soil orders	3
18	25-26	Soil morphology and significance of micromorphological studies soil matric, voids, cutans, pedotubules and glaebules	4
19	27	Soil survey, Defination, concept, objectives, fundamental and applied, importance etc.	3
20	28-29	Soil survey techniques, Conventional and modern techniques, base maps, cadastral maps, toposheet, aerial photo, satellite imaginary, mapping unit and taxonomic units	4
21	30-31	Types of soil survey : Detailed, reconnaissance, semi detailed, detailed and reconnaissance soil series, characterization and procedure for benchmark and established soil series	4
22	32	Soil survey interpretation, soil co relation, soil map cartography, techniques for generation of soil map	3
23	33	Land form and soil relationship land capability classification and land irritability classification	3
24	34	Land evaluation : concept application and approaches	2
25	35	Management of soil and landscape in respective Agro eco system	2
26	36	Soils of India and soils of Maharashtra	3

Practical:

Ex. No.	Name of practical Exercise
1-3	Identification and quantification of minerals in soil fractions
4-5	Morphological properties of soil profile in different land forms
6-8	Classification of soils using soil profiles
9-12	Calculation of weathering indices and its application in soil formation.
13-14	Grouping soils using available soil survey data base in terms of soil quality
15	Cartographuic techniques for preparation of base maps and thematic maps
16	Processing of field sheets, compilation and obstraction of maps in different scales.
17-18	Land use planning exercise using conventional and RS tools

Course Title : SOIL EROSION AND CONSERVATION

Course No. SOILS-505 2+1=3

Theory:

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effect of soil erosion and factors affecting soil erosion; type and mechanism of water erosion; raindrops and soil erosion; rainfall erosivity – estimation as El30 index and kinetic energy; factors affecting water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT III

Wind erosion-types, mechanism and factors affecting wind erosion, extent of problem in the contry.

UNIT IV

Principle of erosion control; erosion control measures- agronomical and enginnering; erosion control structures-their design and layout.

UNIT V

Wind conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid region, waterlogged and wet lands.

UNIT VI

Watershed management – concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio-economic aspects of watershed management; case studies in respect to monitoring and evaluation of watershed; use of remote sensing in assessment and planning of watersheds. .

Practical:

- Determination of different soil erodibility indices –suspension percentage, dispersion ratio, erosion ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index.
- Computation of kinetic energy of falling rain drops.
- Computation of rainfall erosivity index (El30) using rain gauge data.
- Visits to watershed.

Suggested Readings:

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment.* Bull. India Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality.* Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practises.* Oxford & IBH.

Hudson N. 1995. Soil Conservation. lowa State Univ. Press.

Indian Society of Soil Science 2002. *Fundamental of Soil Science. ISSS; New Delhi.*

Oswal MC. 1994. Soil Physics. Oxford & IBH.

Title : SOIL EROSION AND CONSERVATION

Course No: SOILS-505 **2+1 = 3**

Theory:

Sr. No.	Lecture No	Title	Weightage in Marks
1	1-2	History , distribution – identification and description of soil erosion problems in India	2
2	3-4	Forms of soil erosion , effects of soil erosion and factors affecting soil erosion	5
3	5-6	Type and mechanisms of water erosion, raindrops and soil erosion	5
34	7	Rain fall erosivity- estimation as EI_{30} index and kinetic energy	3
5	8-9	Factors affecting water erosion, empirical and quantitative estimation of water erosion	4
6	10-11	Methods of measurement and prediction of runoff	4
7	12-13	Soil losses in relation to soil properties and precipitation	4
8	14-15	Wind erosion – types, mechanism and factors affecting wind erosion	5
9	16	Extent and problem of wind erosion in the country	2
10	17-18	Principles of erosion control erosion control measures – agronomical and engineering	5
MID TERM EXAMINATION			
11	19-20	Erosion control structures – their design and layout	5
12	21	Soil conservation planning ; land capability classification	3
13	22-23	Soil conservation in special problem areas such as hilly, arid and semi-arid regions	5
14	24-25	Waterlogged and wet lands	4
15	26-27-28	Watershed management- concept, objectives and approaches	6
16	29	Water harvesting and recycling	2
17	30	Flood control in watershed management	3
18	31-32	Socioeconomic aspects of watershed management	4
19	33-34	Case studies in respect to monitoring and evaluation of watersheds	5
20	35-36	Use of remote sensing in assessment and planning of watersheds	4

Practical:

1	1-2	Determination of different soil erodibility indices
2	3-4	Suspension percentage
3	5	Dispersion ratio
4	6	Erosion ratio
5	7	Clay ratio
6	8-9	Clay/moisture equivalent ratio
7	10	Percolation ratio
8	11-12	Raindrop erodibility index
9	13-14	Computation of kinetic energy of falling rain drops
10	15-16	Computation of rainfall erosivity index EI_{30} using rain gauge data
11	17-18	Visits to a watersheds

Course Title : SOIL BIOLOGY AND BIOCHEMISTRY

Course No. SOILS-506 **2+1=3**

Syllabus:

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils, soil microbial biomass, microbial interactions, un – culturable soil biota.

UNIT II

Microbiology and biochemistry of root soil interface, phyllosphere, soil enzymes, origin, activities and importance, soil characteristics influencing growth and activity of microflora.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil, biochemical composition and biodegradation of soil organic matter and crop residues, humus formation, cycles of important organic nutrients.

UNIT IV

Biodegradation of pesticides, organic wastes and their use for production of biogas and manures, biotic factors in soil development, microbial toxins in the soils.

UNIT V

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT VI

Biofertilizres – definition, classification, specifications method of production and roles in crop production.

Practical:

- Determination of soil microbial population
- Soil microbial biomass
- Elemental composition, fractionation of organic matter and functional groups
- Decomposition of organic matter in soil
- Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect

Suggested Readings:

1. Introduction to Soil Microbiology. Alexander M. 1977. John Wiley & Sons.
2. Soil Biology. Burges A. & Raw F. 1967. Academic press.
3. Soil Biochemistry. Vol. XI. Mclaren A.D. & Peterson G.H. 1967. Marcel Dekker.

4. Soil Microbial Ecology – Applications in Agricultural & Environmental Management. Metting F.B. 1993. Marcel Dekker.
5. Soil Biochemistry. Paul E.L. & Ladd J.N. 1981. Marcel Dekker.
6. Soil Organisms & litter in the tropics. Reddy M.V. (ed.) Oxford & IBH.
7. Plant root system: Their interaction & function with the soil. Russel R.S. 1977. ELBS & McGraw Hill.
8. Soil Biochemistry. Vol. VIII. Stotzky G. & Bollage JM. 1993. Marcel Dekker.
9. Principles & Application of Soil Microbiology. Sylvia DN. 2005. Pearson Edu.
10. Soil and the environment – An introduction. Wild A. 1993. Cambridge Univ. Press.
11. Soil Microbiology. IInd edition, Tate, R. L. (2000) John Wiley and Sons, New York
12. Soil Microbiology and Biochemistry. 2nd Edition Paul and Clark 1996. Academic Press.
13. Experiments in Soil Biology and Biochemistry (2007), Chhonkar, P. K., Bhadraray, S., Patra, A. K. and Purakayastha, T. J. pp. 182, Westville Publishing House, New Delhi.

Course Title: SOIL BIOLOGY AND BIOCHEMISTRY

Course No. SOILS 506 2+1=3

Theory:

Sr. No.	Lecture No.	Topics to be covered	Weightage in marks
1	1-2	Definition of soil biology and soil biochemistry, Soil biota, soil microbial ecology, types of organisms in different soils, significance of soil biota in soil quality	4
2	3-4	Soil microbial biomass and factors regulating SMB, microbial interactions, un- culturable soil biota	6
3	5-6	Microbiology and biochemistry of root- soil interface, phyllosphere, soil characteristics influencing growth and activity of microflora	8
4	7-8	Enzymes in soils – origin, distribution, activities, and their importance in soil quality	6
5	9-10	Microbial transformations of nitrogen and phosphorus	5
6	11-12	Microbial transformations of sulphur, iron and manganese in soil	6
7	13-14	Biochemical composition and biodegradation of soil organic matter and crop residues, humus formation	6
8	15, 16, 17, 18	Carbon cycle in nature, soil organic carbon – SOC pools, stock, factors regulation SOC, carbon sequestration and management of SOC	6
9	19, 20	Cycles of important organic nutrients (N, S & P)	8
10	21-22	Biodegradation of pesticides, organic wastes and their use for production of biogas and manures	3
11	23-24	Biotic factors in soil development; microbial toxins in soil	4
12	25-26	Preparation and preservation of farmyard manure, animal manure	4
13	27-28	Preparation of rural and urban compost and vermicompost	4
14	29-30	Biofertilizer – definition, classification and specifications	5
15	31-32	Method of production of biofertilizers and their roles in crop production	5

Practical:

Sr. No.	Exercise No.	Topics to be covered
1	1	Determination of soil microbial population by Serial Dilution Plate Technique.
2	2	Determination of soil microbial biomass carbon by Fumigation-Extraction Method
3	3	Determination of soil microbial biomass nitrogen
4	4	Fractionations of organic matter and functional groups
5	5	Monitoring organic matter decomposition in soil through CO_2 evaluation : Alkali Trap Method
6	6-9	Determination of soil enzymes - Urease, Dehydrogenase and phosphates
7	10	Measurement of ammonification
8	11	Determining nitrifying potential (nitrification) of soil
9	12	Measurement of N_2 fixation
10	13	Measurement of S oxidation
11	14	Measurement of P solubilization
12	15	Mineralization of micronutrients
13	16	Study of rhizosphere effect

Course Title: SOIL WATER AND AIR POLLUTION

Course No. SOILS-509 2+1=3

Syllabus:

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutions – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc., water and soil pollutants – their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties / health, and plant growth and human being soil as sink for waste disposal.

UNIT IV

Pesticides – their classification behavior in soil and effect on soil micro organisms.

UNIT V

Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT VI

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide.

UNIT VIII

Remediation / amelioration of contaminated soil and water, remote sensing applications in monitoring and management of soil and water pollution.

Practical:

- Sampling of sewage waters, sewage, sludge, solid/ liquid industrial waters, polluted soils and plants.
- Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents.
- Heavy metals in contaminated soils and plants
- Management of contaminants in soils and plants to safeguard food safely
- Air sampling and determination of particular matter and oxides of sulphur
- Visit to various industrial sites to study the impact of pollutants on soil and plants.

Suggested readings:

Lal R., Kimble J., Levine E. and Stewart B. A. 1995. Soil Management and Greenhouse Effect. CRC Press.

Middlebrooks, E. J. 1979. Industrial Pollution Control. Vol. I. Agro Industries. John Wiley Interscience.

Ross S. M. Toxic Metals in Soil Plant Systems. John Wiley and Sons.

Brady N.C.(2000). The nature and properties of soils. Prentice Hall of India Publ. New Delhi

P. K. Gupta, (1986) Pesticides in Indian Environment, Interprint, New Delhi

V. P. Agrawal and S. V. S. Rana, (1987). Science Development and Environment.

S. C. Chopra and J. S. Kanwar (1976) Analytical Agril. Chemistry, Kalyani Publisher.

L.Khajanchi, R.L. Meena, S.K. Gupta, C.K. Saxena, G. Yadav and G. Singh (2008-09) Diagnosis and Management of Poor quality water and salt affected soil. CSSRI, Karnal, Haryana. (India) and ICAR manual.

Course Title: SOIL, WATER AND AIR POLLUTION

Course No. SOILS 509 2+1

Theory:

Sr. No.	Lecture No.	Topics to be covered	Weightage In Marks
1	1, 2, 3	Pollution-definition, agril. Pollution soil water and air pollution, causes, nature and its extent	5
2	4, 5	Nature and sources of pollutants – pesticides, fertilizer, industrial, urban waste, acid rains and oillspills	5
3	6	Pollution of soil, water and air, their CPC standards	3
4	7, 8, 9	Effect of pollutants on plant, animals, micro organisms in soil, and human beings	7
5	10, 11	Sewage and industrial effluents-definition, composition, properties and their extent	6
6	12, 13, 14, 15	Sewage and industrial effluents, their effect on soil, water and air and plants and human being, Microorganisms soil as sink for waste disposal their methods merits and demerits	9
7	16, 17, 18	Pesticides definition, classification, degradation behaviour in soil, water and air. Their effect on soil properties and microorganisms	9
8	**19**	**Mid term examination**	
9	20, 21, 22, 23, 24	Toxic elements in pollutants, their hazardous effects on plant growth, human health, effect on soil available elements, microbial population	10

10	25, 26, 27	Effect of pollutants on water resources due to leaching of nutrients and pesticides from soil	7
11	28, 29, 30, 31	Effect of pollutants on emission of greenhouse gases, their extents, nature and effect on environment	8
12	32, 33, 34	Use of improved techniques such as dilution, degradation, incineration, concentration, filtration, land disposal etc. nature and extents, merits and demerits	6
13	35, 36	Remote sensing definition, scope in agriculture, and its use in monitoring and management of soil and water pollution	5

Practical:

Sr. No.	Exercise No.	Topics to be covered
1	1	Visit to various industry to study the nature and impact on soil and plant
2	2, 3	Sampling of sewage water, sewage sludge soilid/liquid industrial waste, polluted soil and plant
3	4	Estimation of dissolved and suspended solids in liquid pollutant and pH, EC of solid samples
4	5, 6	Estimation of BOD (Biological) and COD (chemical, oxygen demand) of liquid waste.
5	7, 8	Estimation of nitrate and ammoniacal nitrogen, phosphorus in sample
6	9, 10	Estimation of heavy metal in effluents
7	11, 12, 13	Estimation of heavy metals in soil and plants
8	14, 15	Management of contaminants in soil and plants to safe guard food safer
9	16	Collection of air sample
10	17	Determination of particulate matter in air samples
11	18	Determination of sulphur in air sample

Course Title: ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS

Course No. SOILS-511 **0+2=2**

Syllabus:

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid base, oxidation reduction and complex metric titration, soil, water and plant sampling techniques, their processing and handling.

UNIT II

Determination of nutrient potentials and potential buffering capacity of soils for phosphorus and potassium, estimation of phosphorus, ammonium and potassium fixation capacity of soils.

UNIT III

Principles of visible, ultraviolet and infrared spectrophotometry, atomic absorption, flame photometry, inductively coupled plasma spectrometry chromatographic techniques, mass spectrometry and X-ray defractrometry, identification of minerals by X-ray by different methods

UNIT IV

Electrochemical titration of clays, determination of cation and anion exchange capacities of soils, estimation of exchangeable cations (Na, Ca, Mg, K) estimation of root cation exchange capacity.

UNIT V

Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, B and Mo, analysis of plant materials by digesting plant materials by and dry ashing and soil by wet digestion methods.

UNIT VI

Determination of lime and gypsum requirement of soil, drawing normality exchange isotherms, measurement of redox potential.

UNIT VIII

Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Suggested Readings:

Hesse, P. 1971. Textbook of Soil Chemical Analysis. William Clowes and Sco

Jackson M. L. 1967. Soil Chemical Analysis. Prentice Hall of India.

Keith A. Smith 1991. Soil Analysis. Modern Instrumental Technique. Marcel Dekker.

Kenneth Helrich 1990. Official Methods of Analysis. Assocation Official Analytical Chemists.

Page A. L., Miller R. H. and Keeney D. R. 1982. Methods of Soil Analysis. Part II. SSSA, Madison.

Piper C. E. Soil and Plant Analysis. Hans Publ.

Singh. D. Chhonkar, P. K. And Pandy R. N. 1999. Soil Plant Water Analysis. A Methods Manual. IARI, New Delhi.
Tan K. H. 2003. Soil Sampling, Preparation and Analysis. CRC Press/ Tayor and Francis.
Tandon HLS. 1993. Methods of Analysis of Soils, Fertilizers and Waters. FDCO, New Delhi.
Vogel, A. L. 1979. A Textbook of Quantitative Inorganic Analysis. ELLS, Longman.

Course Title: ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS

Course No. SOILS 511 **0+2=2**

Practical:

Sr. No.	Practical No.	Topics to be Covered
1	1	Preparation of solutions for standard curves, analytical reagents
2	2	qualitative reagents, indicators and standard solutions for acid-base
3	3	Oxidation reduction and complexometric titration
4	4	soil, water and plant sampling techniques, their processing and handling
5	5-6	Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium
6	7	estimation of phosphorus, ammonium and potassium fixation capacities of soils.
7	8-9	Principles of visible, ultraviolet and infrared spectrophotometery
8	10	Atomic absorption
9	11	flame-photometry
10	12	inductively coupled plasma spectrometry
11	13-14	Chromatographic techniques
12	15	Mass spectrometry and X-ray defractrometry
13	16	Identification of minerals by X-ray by different methods
14	17	Electrochemical titration of clays
15-16	18-19	Determination of cation and anion Exchange capacities of soils
17	20-21	Estimation of exchangeable cations (Na, Ca, Mg, K)
18	22	Estimation of root cation exchange capacity
19	23-25	Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo
20	26-27	Analysis of plant materials by digesting plant materials by wet and dry ashing and soil by wet digestion methods
21	28	Determination of lime and gypsum requirement of soil
22	29	Drawing normalized exchange isotherms

23	30	Measurement of redox potential
24	31-32	Analysis of soil extracts and irrigation waters for their soluble cations and anions and interpretation of results.

Course Title: MANAGEMENT OF PROBLEM SOILS AND WATERS

Course No. SOILS-513 2+1=3

Syllabus:

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils, origin and basic concept of problematic soils and factors responsible.

UNIT II

Morphological features of saline, sodic and saline sodic soils, characterization of salt affected soils – soluble salts, ESP, pH, Physical chemical and microbiological properties.

UNIT III

Management of salt affected soils, salt tolerance of crops – mechanism and ratings, monitoring of soil salinity in the field, management principles for sandy, clayey, red lateritic and dry land soils.

UNIT IV

Acid soils – nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils, management of acid soils, biological sickness of soils and its management.

UNIT V

Quality of irrigation water, management of brackish water for irrigation, salt balance under irrigation, characterization of brackish waters, area and extent, relationship in water use and quality.

UNIT VI

Agronomic practices in relation to problematic soils, cropping pattern for utilizing poor quality ground waters.

Practical:

- Characterization of acid, acid sulfate, salt – affected and calcareous soils
- Determination of cations (Na^{+}, K^{+}, Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^{-}, SO_4^{--}, CO_3^{--} and HCO_3^{-}) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils.

Suggested Readings:

Bear F. E. 1964. Chemistry of the Soil. Oxford and IBH

Jurinak J. J. 1978. Salt affected Soils. Department of Soil Science and Biometeorology. Utah State Univ.

USDA Handbook No. 60, 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford and IBH.

TITLE: MANAGEMENT OF PROBLEM SOILS AND WATERS
COURSE NO: SOILS-513 2+1 = 3

Theory:

Sr. No.	Lecture No	Title	Weightage in marks
1	1-2	Area and distribution of problem soils- acidic , saline, sodic and saline –sodic and physically degraded soils	2
2	3-4	Origin and basic concept of problematic soils	3
3	5	Factors responsible for the formation of soils	4
4	6-7	Morphological features of saline, sodic and saline sodic soils	4
5	8-9	Characterization of salt affected soils- soluble salts, ESP, pH,	4
6	10-11-12	Physical and chemical and microbiological properties of problem soils	6
7	13	Management of salt affected soils,	4
8	14	Salt tolerance of crops-mechanism and rating	4
9	15	Monitoring of soil salinity in the field	2
10	16-17	Management principles for sandy, clayey soils	4
11	18-19	Management principles for red lateritic and dry land soils	2
		MIDTERM EXAMINATION	
12	20-21	Acid soils- nature of soil acidity, sources of soil acidity	4
13	22	Effect on plant growth, lime requirement of acid soils	4
14	23-24	Management of acid soils	4
15	25	Biological sickness of soils and its management	4
16	26	Quality of irrigation water	4
17	27-28	Management of brackishs water for irrigation	3
18	29	Salt balance under irrigation	2
19	30-31	Characterization of brackish waters, area and extent of brackish waters	4
20	32-33	Relationship in water use and quality	4
21	34-35	Agronomic practices in relation to problematic soils	4
22	36	Cropping pattern for utilizing poor quality ground water	4

Practical:

Sr. No.	Practical No.	Practicals
1	1	Preparation of saturation paste extract of soils and determination of pH and EC
2	2-3	Characterization of acid , acid sulphate, salt – affected soil
3	4-5	Characterization of calcareous soils
4	6-7	Determination of cations (sodium and potassium) in ground water and soil samples
5	8-9	Determination of cations (calcium and magnesium) in ground water and soil samples
6	10-11	Determination of anions (chlorides and sulphates) in ground water and soil samples
7	12-13	Determination of anions (carbonates and bicarbonates) in ground water and soil samples
8	14-15	Determination of lime requirement of acid soils
9	16-17	Determination of gypsum requirement of sodic soils
10	18	Visit to salt affected soils of command area