Department of Soil Science Syllabus of College of Agri Business Management			
1	**SSAC-231**	**Soil and Water Management**	**2 (1+1)**

Course No: SSAC-231	**Credit: 2 (1+1)**	**Semester: III**
Course Title: Soil and Water Management		
Syllabus		

Theory:

Concept of soil, meaning and definition; soil components and important soil physical (soil texture, structure density, porosity, soil water; soil air, soil temperature and Soil Colour) and chemical (pH, EC, CEC and base saturation) properties in brief, Organic matter, Land capacity classification and suitability. Soils of India and Karnataka, Soil quality and soil health, Distribution of waste land/degraded lands and problem soils in Indi, problems associated and Management of salt affected soils, calcareous soils, acid soils, acid sulphate soils, eroded and compacted soils, flooded / water logged soils, physically constrained soils, polluted soils. Alternate land use strategies for management of problematic soils including bioremediation/phytoremediation. Irrigation water-quality and standards, utilization of poor quality water in agriculture.

Practical:

Soil sample collection and it's preparation for analysis. Determination of soil color, density, porosity and moisture content. Determination of soil texture by feel method. Determination of infiltration rate. Determination of aggregate stability. Determination of soil reaction (pH) and total soluble salts content (EC) in soil. Determination of organic matter in soil. Determination of lime requirement of acid soils. Determination of water-soluble cations. Determination of water-soluble anions. Determination of exchangeable cations (Ca, Mg, Na and K) and computation of ESP. Determination of gypsum requirement of sodic soils. Determination of quality of irrigation water (pH, EC, SAR, RSC, boron, chlorides etc.

Suggested Readings:

- Introduction to soil and water conservation engineering -B.C. Mal Kalyani Publishers, New Dehli
- Principles of Agricultural Engineering(Vol-II)-A.M. Michael and T.P. Ojha Tata Mcgraw Hill Publishing Co Ltd, New Dehli
- Land and water management engineering-VVN Murthy Kalyani Publishers, New Dehli
- Surveying and leveling-(Part-I)-T.P. Kanitkar and Kulkarni Pune Vidyarthi Griha Prakashan, Pune
- Elements of Agricultural Engineering - O.P.Singhal Merath Aman Public House, Meerut.
- ISSS. 2009. Fundamentals of Soil Science. 2nd Ed. Indian Society of Soil Science, New Delhi- 110 012. pp. 728.
- Das D. K. 2011. Introductory Soil Science, 3rd revised and Enlarged Ed, Kalyani Publisher, Ludhiana. pp. 645.
- Brady, N. C. 2016. The Nature and Properties of Soils. 15th edition Publisher: Pearson Education, ISBN: 978-0133254488.
- Daji J A; Daji J A; Kadam J R; Patil N D.1996. Textbook of Soil Science Bombay Media Promoters and publishers Pvt. Ltd.

- Biswas, T.D.; Mukherjee, S.K.. 1995. Text Book of Soil Science 2nd sEd. Tata McGraw Hill Publisher, Delhi pp 433.
- Somawanshi, et al. 2012. Laboratory Methods for Analysis of Soil, Irrigation Water and Plants.., Department of Soil Science and Agriculturasl Chemistry, MPKV., Rahuri. revised Ed. pp. 307.
- Jakson, M.L. 1973. Soil Chemical Analysis. Printice Hall, India, Pvt. Ltd. New Delhi. pp 498.
- Page et. al. 1982. Methods of Soil Analysis, Part 1 and 2. Chemical and Microbiological Properties . 2nd Ed. Soil Science Soc. of America Am. Soc. Agron., Madison, Wisconsin.
- Klute, A. 1986. Methods of Chemical Analysis, 2nd Ed. American Soc. Agron.,Inc. and Soil Science Society of America. Madison, Wisconsin, USA.
- Piper, C. S. 1966. Soil and Plant Analysis. Inters Science . Hans Publisher, Mumbai.
- Black, C. A. 1965. Soil Chemical Analysis, Part I and part II. American Soc. Agron.,Inc. and Soil Science Society of America. Madison, Wisconsin, USA.
- Hesse, P. R. 1971. a Text Book of Soil Chemical Analysis. John Murray, London.
- Richards, L. A. 1968. Diagnosis and Improvement sof Saline Alkali Soils. Oxford and IBH Publication Co. Calcutta.
- Chora, S. L. and Kanwar, J. S. 1991. Analytical Agricultural Chemistry, Kalyani Publisher New Delhi.
- Chapman, H.D., and P.F. Pratt. 1961. Methods of analysis for soils, plants and waters. Division of Agricultural Sciences, University of California.
- Mehara , R. K. 2004. Text Book of Soil Science., ICAR, New Delhi.
- Patil, V. D. and Mali C. V. 2007. Fundamentals of Soil Science, Aman Publication, Meerut.
- Nirankari Lal Singh. 2000. Text Book of Soil Science. Aman Publication, Meerut.
- Dahama , A. K. Organic farming for sustainable agriculture. 19, Agrobotanica Binaker. Pp 53-98 and 210-255.
- Tandon H.L.S. 1994. Recycling of Waste in Agriculture. Fertilizer Development and consultation organization.

Department of Soil Science

M.Sc. (Agri)

Course No	Semester	Course Title	Credit
Soil 501	I	Soil physics	(2+1)
Soil 502	II	Soil fertility and fertilizer use	(2+1)
Soil 503	I	Soil chemistry	(2+1)
Soil 504	I	Soil mineralogy, genesis and classification	(2+1)
Soil 506	II	Soil Biology and Biochemistry	(2+1)
Soil 508	II	Soil, water and air pollution	(2+1)
Soil 510	II	Analytical technique and instrumental methods in soil and Plant analysis	(0+2)
Soil 511	III	Management of problematic soils and water	(1+1)
Soil 591	III	Master's Seminar	(1+0)
Soil 599	III &IV	Master's Research	(30)

Non Credential Course

Course code	Semester	Course Title	Credits
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1=1

Course Title : Soil Physics

I. Course Code : Soil 501

II. Credit Hours : 2+1

III. Aim of the course

To impart basic knowledge about soil physical properties and processes in relationto plant growth.

IV. Theory

Unit I

Basic principles of physics applied to soils, soil as a three-phase system.

Unit II

Soil texture, textural classes, mechanical analysis, specific surface.

Unit III

Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts. Alleviation of soil physical constraints for crop production. Soil erosion and erodibility

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 VIII

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

Unit IX

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.

V. Practical

Determination of B.D, P.D and mass volume relationship of soil, Mechanical analysis by hydrometer and international pipette method, Measurement of Atterberg 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.

I. Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

II.Learning outcome

Experience on the knowledge of soil physical properties and processes in relation to plant growth.

III.**Suggested Reading**

1. Baver LD, Gardner WH and Gardner WR. 1972. Soil Physics. John Wiley & Sons.

2. Ghildyal BP and Tripathi RP. 2001. Soil Physics. New Age International.
3. Hanks JR and Ashcroft GL. 1980. Applied Soil Physics. Springer Verlag.
4. Hillel D. 1972. Optimizing the Soil Physical Environment toward Greater Crop Yields. Academic Press.
5. Hillel D. 1980. Applications of Soil Physics. Academic Press.
6. Hillel D. 1980. Fundamentals of Soil Physics. Academic Press.
7. Hillel D. 1998. Environmental Soil Physics. Academic Press.
8. Hillel D. 2003. Introduction to Environmental Soil Physics. Academic Press.
9. Indian Society of Soil Science. 2002. Fundamentals of Soil Science. ISSS, New Delhi.
10.Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley-Interscience.
11.Kohnke H. 1968. Soil Physics. McGraw Hill.
12.Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
13.Oswal MC. 1994. Soil Physics. Oxford & IBH.
14 Text books of soil physics by Arun Kumar Saha, Anuradha Saha Kalyani Publication New Delhi
15 Soil Physics an Introduction by Manoj K. Shukla Published December 2, 2013 by CRC Press 478 Pages 201 B/W Illustrations
16 Principles of Soil Physics by Rattan Lal, Manoj K. Shukla Published September 27, 2019 by CRC Press 736 Pages
17Applications of Soil Physics 1st Edition - October 28, 1980 Daniel Hillel Elsevier
18 Fundamental Principal of Soil Science by Deepak Sarkar and Abhijit Haldar Today and tomorrows Printers and Publishers

I. Course Title : **Soil Fertility and Fertilizer Use**

II. Course Code **: Soil 502**

III. Credit Hours **: 2 +1**

IV. Aim of the course

To impart knowledge about soil fertility and its control, and to understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

V. Theory

Unit I

Soil fertility and soil productivity; fertility status of major soils group of India; Special emphasis on Maharashtra nutrient sources – fertilizers and manures; Criteria of essentiality, classification, law of minimum and maximum, essential plant nutrients - functions and deficiency symptoms, Nutrient uptake, nutrient interactions in soils and plants; long term effect of manures and fertilizers on soil fertility and crop productivity.

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 – sources, forms, immobilization, mineralization, fixation, 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 – Sources, 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; role in crops and human health; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

Unit VI

Micronutrients – Source, factors affecting their availability, critical limits in soils and plants, 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; site-specific nutrient management; plant need based nutrient management; integrated nutrient management; specialty fertilizers concept, need and category. Current status of specialty fertilizers use in soils and crops of India,

Unit IX

Soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture, DRIS, critical limits of nutrients

Unit X

Definition and concepts of soil health and soil quality; Longterm effects of fertilizersand soil quality.

VI. Practical

- Soil and plant sampling and processing for chemical analysis
- Determination of soil pH, total and organic carbon in soil
- Chemical analysis of soil for total and available nutrients (major and micro)
- Analysis of plants for essential elements (major and micro)

VII. Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students. Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

IX. Suggested Reading

- Brady NC and Weil RR. 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 EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
- Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
- Pierzinsky GM, Sims TJ and Vance JF. 2002. *Soils and Environmental Quality.* 2nd Ed.CRC Press.
- Stevenson FJ and Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
- Tisdale SL, Nelson SL, Beaton JD and Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.
- Troeh FR and Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.
- Soil Fertility Fertilizers and Agrochemicals Joga Pravin K. 2018 Astral International pub Ltd.
- Fertilizers in Indian Agriculture-from 20th to 21st century 2004 Dr. HLS Tondon ,FDCO Sohna Road Gurgaon122018
- Soil Fertility, Fertilizers and INM 2011 Dr. HLS Tondon FDCO Sohna Road Gurgaon122018

I. Course Title : Soil Chemistry
II. Course Code : Soil 503
III. Credit Hours : 2+1
IV. Suggested Reading

To introduce the classical concepts of soil chemistry and to familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

V. Theory

Unit I

Chemical (elemental) composition of the earth's crust, soils, rocks and minerals

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 ofzero-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, Characterization of OM; 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 equilibria; Concept of quantity/intensity (Q/ I) relationship; 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, ECe, ESP, SAR and important relations; soil management and amendments.

Unit VIII

Chemistry and electrochemistry of submerged soils, geochemistry of micronutrients, environmental soil chemistry

VI. Practical

Preparation of saturation past e extract, measurement of pH, EC, CO, HCO, Ca, Mg, Kand Na, Determination of CEC and AEC of soils, Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH meter and conductivity meter, Determination of point of zero-charge and associated surface charge characteristics by the serial potentiometric titration method, Extraction of humic substances, Potentiometric and conductometric titration of soil humic and fulvic acids, (E4/E6) ratio of soil humic and fulvic acids by visible spectrophotometric studies and the D (E4/E6) 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 ascertaining the mechanism of the ligand eXchange process involved, Determination of titratable acidity of an acid soil by BaCl2-TEA method, Determination of Q/I relationship of potassium, Determination of lime requirement of an acid soil by buffer method, Determination of gypsum requirement of an alkali soil.

VII. Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

VIII. Learning outcome

Experience on the knowledge of chemical behavior of soil and their utility in research for solving field problem.

IX. Suggested Reading

- Kim H. Tan, 2010. Principles of Soil Chemistry, 4th Edition, Kindle Edition.
- Daniel G. Strawn, Hinrich L. Bohn, George A. O'Connor 2019 *Soil Chemistry, 5th Edition*
- Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi
- Indian Society of Soil Science 2015. Soil Science: An Introduction. ISSS, New Delhi
- Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.
- SANYAL Text Book of Soil Chemistry Jain Books & Periodicals 1586/113, GANESH PURA, TRI NAGAR, DELHI – 110035
- Bolt GH and Brugge wert MGM. 1978. *Soil Chemistry*. Elsevier.
- Greenland DJ and Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
- Greenland DJ and Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.
- Mc Bride MB. 1994. *Environmental Chemistry of Soils.* Oxford University Press.
- Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford University Press.
- Sposito G. 1984. *The Surface Chemistry of Soils*. oxford University Press.
- Sposito G. 1989. *The Chemistry of Soils*. oxford University Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
- Van Orphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

I. Course Title : Soil Mineralogy, Genesis and Classification
II. Course Code : Soil 504
III. Credit Hours : 2+1
IV. Aim of the course

To acquaint students with basic structure of alumino-silicate minerals and genesis of clay minerals; soil genesis in terms of factors and processes of soil formation, and to enable students conduct soil survey and interpret soil survey reports in terms of land use planning.

V. Theory

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 crystal line and non-crystal line clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils, role of clay minerals in plant nutrition, interaction of clay with humus, pesticides and heavy metals.

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. soil survey, type of soil survey conventional and modern, data interpretations; soil mapping, thematic soil maps by using RS & GIS, cartography, mapping units, techniques for generation of soil maps. 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;

VI. *Practical*

- Separation of sand, silt and clay fraction from soil
- Determination of specific surface area and CEC of clay
- Identification and quantification of minerals in soil fractions
- Morphological properties of soil profile in different land forms
- Classification of soils using soil taxonomy
- Calculation of weathering indices and its application in soil formation
- Grouping soil using available database in terms of soil quality
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VII. *Teaching methods/activities*

Classroom teaching with AV aids, group discussion, oral presentation by students.

VIII. *Learning outcome*

Experience on the knowledge of soil taxonomy and genesis and their utility in research for solving field problem.

IX. Suggested Reading

- Buol EW, Hole ED, Mac Cracken RJ and Southard RJ. 1997. *Soil Genesis*
- *and Classification*. 4th Ed. Panima Publ.
- Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Indian Society of Soil Science 2015. *Soil Science and Intriduction*. ISSS, New Delhi.
- Dr Rattan, J.C.Katyal, B.S. Dwivedi, A.K.Sarkar and T. Bhattacharrya J.C.Tarafdar and S.S.Kukal ; 2020 *Soil Science and Introduction,* Indian Society of Soil Science
- T .Bhattacharyya 2021, Soil Studies Now and Beyond, walnut publication new Delhi
- T. Bhattacharyya 2021, Information Systems and Ecosystems Services : Soil as Examples walnut publication new Delhi
- Soil Series of Maharashtra 1999, NBSS & LUP ICAR , Nagpur
- Soil Survey Manual 2009 NBSS & LUP ICAR , Nagpur
- Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- DiXon JB and Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
- USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
- Wade FA and MattoX RB. 1960. *Elements of Crystallography and Mineralogy*. OXford & IBH.
- Wilding LP and Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*.Elsevier.
- Wilding NE and Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I.

Course Title : Soil Biology and Biochemistry

I. Course Code : Soil 506

II. Credit Hours : 2+1

III. Aim of the course

To teach students the basics of soil biology and biochemistry, including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

IV. Theory

Unit I

Soil biota, soil micro bioecology, types of organism's indifferent soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

Unit II

Microbiology and biochemistry of root-soil interface; phyllo sphere; soil enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora; Root rhizosphere and PGPR.

Unit III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues, microbiology and biochemistry of decomposition of carbonaceous and proteinaceous materials, 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 soil.

Unit V

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

Unit VI

Biofertilizers–definition, classification, specifications, method of production and role in crop production; FCO specifications and quality control of biofertilizers.

Unit VII

Biological indicators of soil quality; bioremediation of contaminated soils; microbial transformations of heavy metals in soil; role of soil organisms inpedogenesis – important mechanisms and controlling factors; soil genomics and bioprospecting; soil sickness due to biological agents; Xenobiotics; antibiotic production in soil.

V. Practical

- Determination of soil microbial population
- Soil microbial biomass carbon
- 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 micronutrients; Study of rhizosphere effect

VI. Teaching methods/ activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

VII. Learning outcome

Experience on the knowledge of soil microbes and their utility in research for solving field problem.

VIII. Suggested Reading

- 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.
- Elder, A. Paul Soil Microbiology, Ecology, and Biochemistry, 3rd Edition, Elsevier
- 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. 91
- 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.
- P. K. Chhonkar , S. Bhadraray , A. K. Patra .2007. Experiments in soil Biology and Biochemistry, westville publishing house
- *Nirupama Tyagi .Soil Biochemistry.(Black Prints Publ.)*
- Paul EA and Clark FE. *Soil Microbiology and Biochemistry.*
- Lynch JM. *Soil Biotechnology*
- Willey JM, Linda M. Sherwood and Woolverton CJ. *Prescott's Microbiology.*
- NS Subba Rao. 1986. *Biofertilizers in Agriculture.* Oxford & IBH pub. Co., New Delhi
- Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
- Tate, R. L. (2000), *Soil Microbiology. II*nd *edition, John Wiley and Sons, New York*
- *Soil Microbiology and Biochemistry. 2*nd *Edition P*aul and Clark 1996. Academic Press.
- Yawalkar KS, Agarwal JP and Bokde S *Manures and Fertilizers.*
- Chhonkar, P. K., Bhadraray, S., Patra, A. K. and Purakayastha, T. J. (2007), *Experiments in Soil Biology and Biochemistry pp. 182,* Westville Publishing House, New Delhi.

I. Course Title ***: Soil, Water and Air Pollution***

II. Course Code **: Soil 508**

III. Credit Hours ***: 2+1***

IV. Aim of the course

To make the student saw are of the problems of soil, water and air pollution associated with use of soils for crop production.

V. Theory

Unit I

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

Unit II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants- their CPCB, MPCB standards and effect on plants, animals and human beings, Pollution Control Act, Policies

Unit III

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

Unit IV

Pesticides–their classification, behavior in soil and effect on soil microorganisms.

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 VII

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

V. Practical

Sampling of sewage waters, sewage sludge, solid/ liquid industrial wastes, polluted soils and plants and their processing, Estimation of dissolved and suspended solids, chemical oxygen demand (COD), biological demand (BOD), measurement of coliform (MPN), nitrate and ammoniacal nitrogen and phosphorus, heavy metal content in effluents, Heavy metals in contaminated soils and plants, Management of contaminants in soil and plants to safe guard food safety, Air sampling and determination of particulate matter and oxides of sulphur, NO_2 and O_2 conc**.** Visit to various industrial sites to study the impact of pollutants on soil and plants.

VI. Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

VII. Learning outcome

Management of soil and water pollution

VIII. Suggested Reading

- Lal R, Kimble J, Levine E and Stewart BA. 1995. *Soil Management and Greenhouse Effect'*s Press.
- Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.
- Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.
- Vesilund PA and Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.
- A.K. Singh & Alka Tomar K.K. Singh, Asha Juwarka, 2007. Air, Water and Soil Pollution , Kalyani Publishers.

Course Title: Analytical Technique and Instrumental Methods in Soil and Plant Analysis

I. Course Code : Soil 510

II. Credit Hours : 0+2

III. Aim of the course

To familiarize the students with commonly used instruments – their working, preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

IV. Practical

Unit I

Preparation of solutions for standard curves, indicators and standard solutions for acid-base, oxidations reduction and complexometric titration; soil, water and plant sampling techniques, their processing and handling.

Unit II

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

Unit III

Principles of visible, ultra violet and infrared spectrophotometer, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray diffractometer; identification of minerals by X-ray by different methods, CHNS analyzer.

Unit IV

Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

Unit V

Wet digestion/fusion/extraction of soil with aqua Regia with soil for elemental analysis; triacid/di-acid digestion of plant samples; determination of available and total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in soils; determination of total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in plants

Unit VI

Drawing normalized exchange isotherms; measurement of redox potential.

V. Teaching methods/activities

Classroom teaching and laboratory practical's

VII. Learning outcome

Development of confidence for setting soil testing laboratory.

VIII. Suggested Reading

- Tandon HLS.2017. Method of Analysis of Soils, Plants, Water, Fertilizers & Organic Manures. FDCO, New Delhi.
- 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 and Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
- Piper CE. *Soil and Plant Analysis*. Hans Publ.
- Singh D, Chhonkar PK and 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.

I. *Course Title* : Management of Problematic Soils and Water
II. Course Code : Soil 511
III. *Credit Hours* : 1 +1
IV. Aim of the course

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

V. *Theory*

Unit I

Area and distribution of problem soils of India with special emphasis on Maharashtra—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; salt stress meaning and its effect on crop growth, monitoring of soils salinity in the field; management principles for sandy, clayey, red lateritic, calcareous and dryland 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 groundwaters.

VI. Practical

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

VII. Teaching methods/activities

Classroom teaching with AV aids, group discussion, oral presentation by students.

VIII. Learning outcome

Experience on solving field problem of problem soil and waters.

IX. Resources

- Bear FE. 1964. *Chemistry of the Soil*. oxford & IBH.
- Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State University
- USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. oxford

& IBH.
- Tandon HLS .2014. Soil Health Management: Physical, Chemical, biological, environmental, intensive cropping, dryland farming, management of problem soils. FDCO, New Delhi.

Department of Soil Science

Agri. Polytechnic Syllabus

Sr.No.	Semester	Course No	Credit	Course Title
1	III	SSAC-231	3 (2 + 1)	Fundamentals of Soil Science
2	IV	SSAC-242	3 (2 + 1)	Soil Fertility Management
4	VI	SSAC-364	2 (1+1)	Problematic Soils and their Management

1.	**Course :**	SSAC-231	**Credit:** 3 (2+1)	**Semester-III**
	Course title:	Fundamentals of Soil Science		

Syllabus

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Theory

Soil, definition & importance. Pedological and edaphological concepts of soil. Soil genesis: soil forming rocks and minerals, weathering. Processes and factors of soil formation. Soil profile. Components of soil. Soil physical properties. Soil texture- Methods of particle size analysis. Structure of Soil. Density and porosity of Soil. Soil colour. Consistence and plasticity. Elementary knowledge of soil taxonomy classification and soils of India. Soil water retention. Movement and availability of Water. Soil air, composition, importance. Flow of heat in soil. Soil temperature and plant growth. Soil reaction-pH. Soil acidity and alkalinity. Effect of pH on nutrient availability. Soil colloids - inorganic and organic. Silicate clays. Constitution and properties of silicate clays. Sources of charge on soil colloids and ion exchange. Cation exchange capacity. Base saturation. Soil organic matter: composition & Importance. Influence of soil organic matter on soil properties. Humic substances - nature and properties. Soil organisms: macro and micro organisms. Beneficial and harmful micro organisms.

Practical

Study of soil sampling tools, collection of representative soil sample. Identification of soil forming rocks and minerals. Study of soil profile in field. Determination of soil moisture content and maximum water holding capacity. Determination of soil texture by feel method. Studies of capillary rise phenomenon of water in soil column. Determination of soil colour. Determination of soil pH and electrical conductivity. Estimation of organic carbon content of soil. Study of Soil map of Maharashtra. Determination of particle size analysis. Determination of bulk density of soil. Determination of soil temperature. Determination cation exchange capacity of the soil

Suggested Readings

1) **Text Book of Soil Science.** 2004. Mehara, R. K., ICAR, New Delhi.
2) **Fundamentals of Soil Science.** 2007. Patil, V. D. and Mali C. V., Aman Publication, Meerut.
3) **Text Book of Soil Science.** 2017. T. Biswas and S. Mukherjee, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4) **Fundamendals of Soil Science.** 2nd Edn., 2012. Indian Society of Soil Science (ISSS).

2.	**Course :**	SSAC-242	**Credit:** 3 (2+1)	**Semester-IV**
	Course title:	Soil Fertility Management		

Syllabus

Theory

Importance and classification of organic manures. Properties and methods of preparation of bulky manures. Green/leaf manuring – Types, Importance. Transformation reactions of organic manures in soils and importance of C:N ratio in rate of decomposition of manures. Chemical fertilizers: classification. Composition and properties of major nitrogenous fertilizer. Compositional properties of Phosphatic, potassic fertilizers, secondary & micronutrient fertilizers. Complex fertilizers, nano-fertilizers, Soil amendments. History of soil fertility and plant nutrition. Criteria of essentiality. Role of essential Nutrients. Deficiency of essential Nutrients. Toxicity symptoms of essential plant nutrients. Mechanisms of nutrient transport to plants. Factors affecting nutrient availability to plants. Integrated Nutrient Management (INM). Chemistry of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients. Soil fertility evaluation. Forms of nutrients in soil. Plant analysis, rapid plant tissue tests. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE). Methods of application of manures & fertilizers under rainfed and irrigated conditions.

Practical

Identification of different fertilizers used in Agriculture. Identification of different manures samples used in Agriculture. Organic matter content from manures samples. Estimation of N, P, K from manure sample. Determination of moisture from manures. Determination of N from urea fertilizers. Determination of P from phosphatic fertilizer. Determination of K from potassic fertilizer. Study of Indicator plants for Soil fertility management. Determination of available nitrogen from the soil by alkaline permanganate method. Determination of available phosphorus from the soil by Watanabe and Olsen (1965) method. Determination of available potassium from the soil (neutal N ammonium acetate method). Determination of micronutrient from the soil Lindsay and Norvell (1978) method.

Suggested Readings

1) **Fundamentals of Soil Science.** 2nd Edn. 2012. ISSS. Indian Society of Soil Science, New Delhi- 110 012.
2) **Handbook of Manures and Fertilizers.** 1971. ICAR publication.
3) **Manures and Fertilizers.** 1967. Yawalkar, K. S. , Agarwal, J. P. and Bokde, S., Agri-Horticultural Publication.
4) **Text Book of Plant Nutrient Management.** 2014. Rajendra Prasad, S. Pathak, A. K. Patra and Yashbir Singh Shivay.
5) **Soil Fertility and Fertilizers.** 8th Edn., 2016. J. L. Havlin, S. L. Tisdale, W. L. Nelson and J. D. Beaton. Pearson Education, India.

3.	**Course :**	SSAC-364	**Credit:** 2 (1+1)	**Semester-VI**
	Course title:	Problematic Soils and their Management		

Syllabus

Theory

Soil quality and health, Distribution of Waste land and problem soils in India. Theircategorization based on properties. Reclamation and management of Saline and sodic soils, Acidsoils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.Irrigation water – quality and standards, utilization of saline water in agriculture. Remotesensing and GIS in diagnosis and management of problem soils.Multipurpose tree species, bio remediation through MPTs of soils, land capability andclassification, land suitability classification. Problematic soils under different Agro-ecosystems.

Practical

Saturation paste extract, its analysis for pHe and ECe, soluble cations and anions, competition of SAR and RSC. Exchangeable sodium percentages of soil, gypsum requirement of sodic soil, lime requirement of acidic soils. Irrigation water sampling technique, sewage water.Determination of pH, EC, soluble cations and anions. Computation of RSC and SAR, BOD and COD of sewage water, Satellite image analysis of salt affected soils.

Suggested Readings

1) **Diagnosis and Improvement of Saline and Alkali Soils.** Vol. No. 60. 1954. Richards, L. A. United State Department of Agriculture.
2) **Nature, Properties and Management of Saline and Alkali Soils.** 2010. Maliwal, G. L. and Somani, L. L. Agro-tech Publishing Academy, Udaipur.
3) **Soil Resource Inventory and Management of Problematic [i.e. Problematic] Soils**. 2012. Mahendran, *et al*. Agrotech Publishing Academy (ISBN 10: 818321097X / ISBN 13: 9788183210973).
4) **Salt-Affected Soils and their Management.** 1988. Abrol, I. P., Yadav, J. S. P and Massoud. F. I. FAO Soils Bulletin 39. Food & Agriculture Organization of the United Nations, Rome.
5) **Agricultural Salinity Management in India.** 1998. Tyagi, N.K. and P.S. Minhas. CSRI, Karnal.
6) **Chemical Changes and Nutrient Transformation in Sodic/ Poor Quality water Irrigated Soils** . 2008. Yaduvanshi, N. P. S. CSRI., Karnal.
7) **Diagnostics, Remediation and Management of Poor Quality Waters: Lectures for Summer School**. 2012. Dey, P. &, Gupta, S. K.
8) **Salinity Management for Sustainable Agriculture in Canal Commands.** 2011. R. L. Meena, S. K. Gupta, R. K. Yadav and D. K. Sharma,Published by CSRI., Kernal
9) **Twenty-five Years of Research on Management of Salt Affected Soils and Use of Saline Water in Agriculture.** 1998. CSRI, Karnal, Haryana.
10) **Fundamentals of Soil Science.** 2007. Patil, V. D. and Mali C. V., Aman Publication, Meerut
11) **Introductory Soil Science.** Das, D. K.
12) **The Nature and Properties of Soils.** 15th edn. 2016. Brady, N. C., Pearson Education, ISBN: 978-0133254488
13) **The Chemistry of Soil.** Firman Bear
14) **Text Book of Pedology Concepts and Applications.** J. Sehgal
15) **FAO United Nations Soil Portal**.