

**Course Curriculum of Ph.D.  
Programme**

**(Major, Minor, Supporting and Non-credit  
courses)**

**Ph.D. (Ag.) IN SOIL SCIENCE  
SEMESTER-II**



**SHRI VAISHNAV INSTITUTE OF  
AGRICULTURE, INDORE  
SHRI VAISHNAV VIDYAPEETH  
VISHWAVIDYALAYA, INDORE**





**Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore**  
**Shri Vaishnav Institute of Agriculture**  
**Ph.D. (Ag.) Soil Science**

| Course Code        | Course Name                | TEACHING & EVALUATION SCHEME |               |                      |                         |                      |          |          |          |
|--------------------|----------------------------|------------------------------|---------------|----------------------|-------------------------|----------------------|----------|----------|----------|
|                    |                            | Theory                       |               |                      | Practical               |                      | Credits  |          |          |
|                    |                            | END SEM University Exam      | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L        | P        | Total    |
| <b>PHDSOIL 603</b> | Physical Chemistry of Soil | <b>60</b>                    | <b>00</b>     | <b>40</b>            | <b>00</b>               | <b>00</b>            | <b>2</b> | <b>0</b> | <b>2</b> |

**1. Legends: L - Lecture; P – Practical**

**2. \*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.**

**Objective**

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

**Theory**

**UNIT I**

Colloidal chemistry of inorganic and organic components of soils—their formation, clay organic interaction.

**UNIT II**

Predictive approaches for cation exchange equilibria- thermodynamics, empirical and diffuse double layer theory (DDL)- relationships among different selectivity coefficients; structure and properties of diffuse double layer.

**UNIT III**

Thermodynamics of nutrient transformations in soils; Climate change effects on mineralogy and surface properties of variable charge; cationic and anionic exchange and their models, molecular interaction.

**UNIT IV**

Adsorption/desorption isotherms-Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system).

**UNIT V**

Common solubility equilibria-carbonates, ironoxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use).

**Teaching methods/activities**

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

**Learning outcome**

Experience on the knowledge of soil chemical behaviour on research for solving field problems.

**Suggested Reading**

- Bear RE. 1964. Chemistry of the Soil. Oxford & IBH.
- Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
- Fried M and Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition. Academic Press.
- Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
- Greenland DJ and Hayes MHB. 1978. Chemistry of Soil Constituents. John Wiley & Sons.
- Jurinak JJ. 1978. Chemistry of Aquatic Systems. Department of Soil Science and Biometeorology, Utah State University
- McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
- Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC 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.
- van Olphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons.

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|--------------------|---|-------------------------------|------------------|-------------------------|-------------------------------|-------------------------|----------|----------|----------|
|                    |   | Theory                        |                  |                         | Practical                     |                         | Credits  |          |          |
|                    |   | END SEM<br>University<br>Exam | Mid term<br>exam | Teachers<br>Assessment* | END SEM<br>University<br>Exam | Teachers<br>Assessment* | L        | P        | Total    |
| <b>PHDSOIL 604</b> | <b>Soil Genesis and Micromorphology</b> | <b>60</b>                     | <b>00</b>        | <b>40</b>               | <b>00</b>                     | <b>00</b>               | <b>2</b> | <b>0</b> | <b>2</b> |

**1. Legends: L - Lecture; P – Practical**

**2. \*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.**

**Objective**

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

**Theory**

**UNIT I**

Pedogenic evolution of soils; soil composition and characterization.

**UNIT II**

Weathering and soil formation–factors and pedogenic processes

**UNIT III**

Stability and weathering sequences of minerals.

**UNIT IV**

Assessment of soil profile development by mineralogical and chemical analysis.

**UNIT V**

Micro-pedological features of soils–their structure, fabric analysis, role in genesis and classification.

**Teaching methods/activities**

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

**Learning outcome**

Experience on the knowledge of soil micro pedology and soil taxonomy on research for solving field problems.

**Suggested Reading**

- Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Edu.
- Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. Soil Genesis and Classification. 4th Ed. Panima Publ.
- Dixon JB and Weed SB. 1989. Minerals in Soil Environments. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. Clay Mineralogy. McGraw Hill.
- Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.
- Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi
- Sehgal J. 2002. Pedology - Concepts and Applications. Kalyani.
- USDA. 1999. Soil Taxonomy. Hand Book No. 436. 2nd Ed. USDA NRCS, Washington.
- Wade FA and Mattox RB. 1960. Elements of Crystallography and Mineralogy. Oxford & IBH.

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|             |                                     | END SEM University Exam      | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L       | P | Total |
| PHDSOIL 605 | Biochemistry of Soil Organic Matter | 60                           | 00            | 40                   | 00                      | 00                   | 2       | 0 | 2     |

1. **Legends:** L - Lecture; P – Practical

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**Objective**

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

**Theory**

**Unit I**

Organic matter in soils and its maintenance Role of organic matter in soil productivity; humus levels in soils; current thinking on the maintenance of organic matter in the soils. Carbon retention and sequestration.

**Unit II**

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

**Unit III**

Nutrient transformation–N, P, S; tracemetal interaction with humic substances, significance of chelation reactions in soils.

**Unit IV**

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clayorganic matter complexes.

**Unit V**

Humus-pesticide interactions in soil, mechanisms.

**Teaching methods/activities**

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

**Learning outcome**

Experience on the knowledge of soil biochemistry on research for solving field problems.

**Reading Materials**

- Lynch JM, Willey JM. Soil Biotechnology.
- Paul EA and Clark FE. Soil Microbiology and Biochemistry
- Sherwood LM and Woolverton CJ. Prescott's Microbiology.
- Subba Rao NS. Advances In Agricultural Microbiology

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| PHDSOIL 606 | Soil Resource Management | 60                           | 00            | 40                   | 00                      | 00                   | 3       | 0 | 3     |

**1. Legends: L - Lecture; P – Practical**

**2. \*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.**

**Objective**

To impart the students basic holistic knowledge on soil resource and latest developments in its sustainable use.

**Theory**

**UNIT I**

Relevance of soil management to sustainable agriculture; soil as a natural resource for biomass production, filtering, buffering, transportation of solutes, genes, and geogenic source of raw materials; soil as a source and sink of greenhouse gases.

**UNIT II**

Concept of sustainable land management (SLM); spatial variability of soils; soil quality and food security; soil quality indices, conservation agriculture in relation to soil quality; soil resilience and resistance.

**UNIT III**

Types, factors and causes of land degradation and desertification; GLASOD classification; application of GIS and remote sensing in monitoring, diagnosis and mapping land degradation; history, distribution, identification and description of soil erosion problems in India; forms of soil erosion; impact of soil erosion-on-site and off-site effects; strategies for erosion control and conservation; soil conservation in hilly, arid, semiarid, coastal and diaralands. Management of forest, peat and muck soils.

**UNIT IV**

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wetlands; land restoration and conservation techniques—erosion control, reclamation of salt affected soils; mine land reclamation, afforestation, organic products, soil fauna and biodegradation.

**UNIT V**

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 watersheds. Agro-ecological regions of India; potentials and constraints of soils of different regions; land evaluation and rationalizing land use, decision support system with relation to land management; national and international soil policy considerations.

### **Teaching methods/activities**

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

### **Learning outcome**

Experience on the knowledge of soil resources on research for solving field problems.

### **Suggested Reading**

- Abrol IP and Dhruvanarayana VV. 1990. Technology for Wasteland Development. ICAR, New Delhi.
- Andriess JP. 1988. Nature and Management of Tropical Peat Soils, Soil Resources, FAO Soils Bulletin 59, Management and Conservation Service, Land and Water Development Division, FAO, Rome
- Blackwell, Dent D and Young A. 1981. Soil Survey and Land Evaluation. George Allen and Unwin, London.
- Burrough A and McDonnell RK. 1998. Principles of Geographical Information System. Oxford University Press.
- Dan Binkley D and Fisher R. 2012. Ecology and Management of Forest Soils, 4th Edition, Wiley.
- FAO. 1996. Land Quality Indicators and their Use in Sustainable Agriculture and Rural Development. FAO Land and Water Bulletin.5. FAO, Rome.
- Faroq M and Siddique K. (Ed.). 2015. Conservation Agriculture, Springer Nature, Chennai, India.
- FESL. 1993. An International Framework for Evaluating Sustainable Land Management, FAO World Soil Resources Report No. 73, Land Development Division, FAO, Rome.
- ISSS. 1994. Management of Land and Water Resources for Sustainable Agriculture and Environment. Diamond Jubilee Symposium Publication, Indian Society of Soil Science, New Delhi.
- Lal R, Blum WEH, Valentine C and Stewart BA. (Editors). 1988. Methods for Assessment of Soil Degradation. CRC Press, Boca Raton.
- Mulders MA. 1987. Remote Sensing in Soil Science. Elsevier Science Publishers, Amsterdam.
- Sehgal J. 2014. A Text Book of Pedology Concepts and Application. Kalyani publishers, New Delhi.
- SSSA 1996. Methods for Assessing Soil Quality. SSSA Publication Number 49, Madison, Wisconsin, USA.

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| <b>PHDAGRON606</b> | <b>Soil Conservation and Watershed Management</b> | <b>60</b>                    | <b>00</b>     | <b>40</b>            | <b>30</b>               | <b>20</b>            | <b>2</b> | <b>1</b> | <b>3</b> |

**1. Legends: L - Lecture; P – Practical**

**2. \*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.**

**Objective**

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

**Theory**

**UNIT I**

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

**UNIT II**

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; mulching, tillage, cropping system vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

**UNIT III**

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

**UNIT IV**

Land use capability classification, alternate land use systems; agro-forestry; ley farming; jhum management - basic concepts, socio-ethnic aspects, its layout.

**UNIT V**

Drainage, methods of drainage, Drainage considerations and agronomic management; rehabilitation of abandoned jhum lands and measures to prevent soil erosion.

**Practical**

- Study of different types of erosion
- Determination of dispersion ratio
- Estimation of soil loss by Universal Soil Loss Equation
- Estimation of soil loss by wind erosion
- Measurement of runoff and soil loss
- Field studies of different soil conservation measures
- Laying out run-off plot and deciding treatments

- Identification of different grasses and trees for soil conservation
- Visit to watershed areas
- Visit to a soil conservation research centre, demonstration and training centre.

### **Teaching methods/activities**

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

### **Learning outcome**

Experience on the knowledge of soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

### **Reading Materials**

Arakeri HR and Roy D. 1984. Principles of Soil Conservation and Water Management. Oxford & IBH.

- Dhruvanarayana VV. 1993. Soil and Water Conservation Research in India. ICAR.
- FAO. 2004. Soil and Water Conservation in Semi-Arid Areas. Soils Bull., Paper 57.
- Frederick RT, Hobbs J, Arthur D and Roy L. 1999. Soil and Water Conservation: Productivity and Environment Protection. 3rd Ed. Prentice Hall

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|             |  | Theory                       |               |                      | Practical               |                      | Credits |   |       |
|             |  | END SEM University Exam      | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L       | P | Total |
| PHDSTAT 522 | Data Analysis Using Statistical Packages | 60                           | 00            | 40                   | 30                      | 20                   | 2       | 1 | 3     |

**1. Legends: L - Lecture; P – Practical**

**2. \*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.**

**Objective**

This course is meant for exposing the students in the usage of various statistical packages for analysis of data. It would provide the students a hands on experience in the analysis of their research data. This course is useful to all disciplines.

**UNIT I**

Introduction to various statistical packages: Excel, R, SAS, SPSS. Data Preparation; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

**UNIT II**

Test for normality; Testing of hypothesis using chi-square, t and F statistics and Z-test.

**UNIT III**

Data preparation for ANOVA and ANCOVA, Factorial Experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

**UNIT IV**

Analysis of mixed models; Estimation of variance components; Correlation and regression analysis, Probit, Logit and Tobit Models.

**UNIT V**

Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Neural networks.

**Practical**

- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data.
- Testing the hypothesis for one sample t-test, two sample t-test, paired t-test, test for large samples - Chi-squares test, F test, one-way analysis of variance.
- Designs for Factorial Experiments, fixed effect models, random effect models, mixed effect models, estimation of variance components.
- Linear regression, Multiple regression, Regression plots.
- Discriminant analysis - fitting of discriminant functions, identification of important variables.
- Factor analysis. Principal component analysis - obtaining principal component.

**Suggested Reading**

- Anderson C.W. and Loynes R.M. 1987. Teaching Practical Statistics. John Wiley.
- Atkinson A.C. 1985. Plots Transformations and Regression. Oxford University Press.
- Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. Graphical Methods for Data Analysis. Wadsworth, Belmont, California.

- Chatfield C. 1983. Statistics for Technology. 3rd Ed. Chapman & Hall. Chatfield C. 1995. Problem Solving: A Statistician's Guide. Chapman & Hall.
- Cleveland W.S. 1985. The Elements of Graphing Data. Wadsworth, Belmont, California.
- Ehrenberg ASC. 1982. A Primer in Data Reduction. John Wiley.
- Erickson B.H. and Nosanchuk T.A. 1992. Understanding Data. 2nd Ed. Open University Press, Milton Keynes.
- Snell E.J. and Simpson HR. 1991. Applied Statistics: A Handbook of GENSTAT Analyses. Chapman and Hall.
- Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
- Tufte ER. 1983. The Visual Display of Quantitative Information. Graphics Press, Cheshire, Conn.
- Velleman PF and Hoaglin DC. 1981. Application, Basics and Computing of Exploratory Data Analysis. Duxbury Press.
- Weisberg S. 1985. Applied Linear Regression. John Wiley.
- Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
- Wetherill GB. 1986. Regression Analysis with Applications. Chapman & Hall.
- Cleveland WS. 1994. The Elements of Graphing Data, 2nd Ed., Chapman & Hall

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