

SHRI GURU RAM RAI UNIVERSITY

Pathribagh, Dehradun-248001, Uttarakhand, India

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Syllabus

Pre-Ph.D. Course Work (Soil Science)



**Effective from Academic Session
(2021-2022)**

Pathribagh, Dehradun-248001, Uttarakhand

Pre Ph.D. Course Department of Soil Science

Curriculum and Syllabus for Ph.D. (Soil Science)

Table: The course structure and Assessment scheme:

S.N	Course no.	Subject	Credits (L:T:P)	Total credit
Core Courses				
1.	PRMC-601	Paper I: Research Methodology*	2:1:1	4
2.	PRPE-602	Paper II: Research & Publication Ethics*	1:1:0	2
3.	PPSC-603	Soil Genesis and Micromorphology *	4:0:0	4
4.	PPSS-604	Doctoral Seminar- I*	2 (0:0:2)	4
		Doctoral Seminar- II*		
		Field work/workshop*	2(0:2:0)	
5.	PPSE-605	Physical Chemistry of Soil **	4:0:0	4
6.	PPSE-606	Soil Resource Management **	4:0:0	4
7.	PPSE-607	Clay Mineralogy **	3:0:1	4
8.	PPSE-608	Recent Trends in Soil Microbial Biodiversity **	3:0:1	4
Ph.D. Thesis Research				
6.	PPSC-700	Ph.D. Thesis	Non-credit	-
Total				18

*Core courses

**Elective courses (Students have to select any *one* course from above elective courses)

Programme Outcome:

P.O. 1: Develop deeper understanding of a subject for its application in addressing social and scientific issues.

P.O. 2: To understand the critical aspects of conducting ethical research for sustainable development.

P.O. 3: To develop the reasoning-based solution to the scientific problem.

P.O.4: To understand the impact of research & development on environment safety and sustenance.

P.O.5: Inculcate the leadership skills required to identify the problem and finding the solution in

coherence with the teamwork.

P.O.6: To develop the skill set of designing and executing experiments pertaining to a targeted scientific problem.

P.O.7: Develop the analytical skills prerequisite for analyzing the research findings and correlating with the set objectives.

P.O.8: To develop meticulous scientific writing skills for presenting the research outcomes.

Programme Specific Outcomes:

P.S.O. 1: To develop the skills in advances in Soil Science.

P.S.O. 2: To educate the various management strategies for soil fertility, crop response and sustainable agriculture.

P.S.O. 3: To disseminate principles, planning, layout and analysis of soil and crops.

P.S.O. 4: Develop skills in ethical dimensions of research work in Soil Science

Pre- Ph. D. Courses

PROGRAMME (ONE SEMESTER COURSE)

CORE COURSE-I

PRMC-601: Paper-I Research Methodology

Credits: 04

Unit I- Concept & Types of Research

Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem – Research Design, Classification of Research, Pure and Applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/Study, Evaluation research/Studies, Action Research, Experimental Research, Analytical Study of Statistical Method, Historical Research,

Unit II –Methods Research

Surveys, Case Study, Field Studies General Survey of various Methods including Survey Method, Interdisciplinary Method, Cash Study Method, Sampling Method, Statistical Method, Observation Method, Interview Method, Schedule Method, Questionnaire Method, Documentary Method, Library Method, Historical Method and Scientific Method. Characteristic Features of Scientific Method; Empirical Verifiable, Cumulative, Self - Correcting, Deterministic, Ethical & Ideological neutrality (Value Free).

Unit III- Data Collection and Data Analysis

Collection, Objectives and Classification of Data, Aims, Methods and Objects of Tabulation of Data, Forms and Processes of Interpretation and Presentation of Data.

Primary, Secondary and Tertiary Data. Construction and adaptation of instruments, administration of questions and tests, Tabulation of data. Data organization in SPSS & Excel, Graphical representation of data.

Definition and Aims of Content Analysis, Problems of Content Analysis, Computer and Content Analysis Discussion and Interpretation of results, Testing of Hypothesis: Logical and Statistical Techniques.

Unit IV- Report Writing

Locating Information on a Topic of Interest, Acquiring Copies of Articles of Interest, The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables, Levels of Measurement, Various Paradigms including Formism, Mechanism, Organicism, Pragmatism, The Basic Format for a Research Report, Identification of the Parts of a Research Report, Citation and Referencing Styles, Essentials of Report Writing, Aids for Writing Good Research Report.

Suggested Readings

- Bagchi, KanakKanti (2007). Research Methodology in Social Sciences: A Practical Guide, Delhi, Abijeet Publications.
- Sharma, B.A.V. et al., (2000). Research Methods in Social Sciences, New Delhi, Sterling Publishers.
- B.A.V. Busha, C. H and Harter, S. D. (1980). Research Methods in Librarianship, New Academic Press.
- Cooper, R. Donald and Pamela S. Schindler (2003). Business Research Methods, Delhi, Tata McGraw-Hill.

- Flyvbjerg, Bent (2001). Making Social Science Matter: Why Social Inquiry Fails and How it can succeed Again, United Kingdom, Cambridge University Press.
- Goodde and Hatte (1952). Methods in Social Research, New York, McGraw – Hill.
- Gopal, M.H (1970) An Introduction to Research Procedures in Social Sciences, Bombay, Asia Publishing House.
- Hunt, Morton (1989) Profiles of Social Research: The Scientific Study of Human Interactions, Bombay, PopularPrakashan.
- Kothari, C.R (2004) Research Methodology: An Introduction, Delhi, New Age.

Course Outcome:

- CO1. To develop understanding of the basic framework of research process.
CO2. To develop an understanding of various research designs and techniques.
CO3. To identify various sources of information for literature review and data collection.
CO4. To develop an understanding of the ethical dimensions of conducting applied research
CO5. Appreciate the components of scholarly writing and evaluate its quality.

PRPE-602: Paper-II Research& Publication Ethics

Credits: 02

Philosophy and Ethics

- Introduction to Philosophy: definition, nature and scope, concept, branches
- Ethics: definition, moral philosophy, nature of moral judgements and reactions

Scientific Conduct

- Ethics with respect to science and research
- Intellectual honesty and research integrity
- Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)
- Redundant publications: duplicate and overlapping publications, salami slicing
- Selective reporting and misrepresentation of data

Publication Ethics

- Publication ethics: definition, introduction and importance
- Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
- Conflicts of interest
- Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice - versa, types
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

Practical

Open Access Publishing

- Open access publications and initiatives
- SHERPA/ RoMEO online resource to check publisher copyright & self- archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal

Suggester, etc.

Publication Misconduct

Group Discussions

- Subject specific ethical issues, FFP, authorship
- Conflicts of interest
- Complaints and appeals: examples and fraud from India and abroad

Software tools

Use of plagiarism software like Turnitin, Urkund and other open source software tools

Databases and Research Metrics

Databases

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

Research Metrics

- Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
- Metrics: h- index, g index, i10 index, altmetrics

Course Outcome:

CO1. To develop an understanding of research ethics, publications misconduct and plagiarism.

CO2. To develop Intellectual honesty and research integrity.

CO3. To identify various sources of information for data bases and research matrices.

CO4. To develop an understanding of Open access publications and initiatives.

CO5. Appreciate the components of scholarly writing and evaluate its quality.

CORE COURSE II

PPHC-603: Soil Genesis and Micromorphology Credits: 04

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; stability and weathering sequences of minerals.

Unit III

Assessment of soil profile development by mineralogical and chemical analysis.

Unit IV

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

Suggested Readings

- 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.

Course Outcome:

CO1. Experience on the knowledge of soil micro pedology and soil taxonomy on research for solving field problems.

CO2. Summarise recent advances in propagation and fruit production.

CO3. Categorize biological stress factors, strategies to overcome stress effects.

CO4. Estimate nutrient and water deficiency.

CORE COURSE III

PPSS-604: Doctoral Seminar

Credits: 04

Course Outcome:

CO.1: Acquaint with scientific terms, concepts and content preparation, etc.

CO.2: Outline and summarize presentation.

CO.3: Present and implement photographs and sketches in power point to give valuable information.

CO.4: correlate research proposal or synopsis, report, manuscripts/article and publications.

ELECTIVE COURSE

The Candidates are required to opt any one course from the following elective courses:

Elective courses

PPSE-605: Physical Chemistry of Soil: 04

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).

Suggested Readings

- 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.
- Spósito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford University Press.
- Spósito G. 1984. *The Surface Chemistry of Soils*. Oxford University Press.
- Spósito 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.

Course Outcome:

- CO 1. Experience on the knowledge of soil chemical behaviour.
- CO 2. Thermodynamics of nutrient transformations in soils
- CO3. Climate change effects on mineralogy.
- CO4. Understanding on research for solving field problems.

PPSE-606: Soil Resource Management: 04

Objective

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

Unit I

Relevance of soil management to sustainable agriculture; soil as a natural resource for biomass production, filtering, buffering, transportation of solutes, genereserves, 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 are as 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.

Unit VI

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.

Suggested Readings

- Abrol IP and Dhruvanarayana VV. 1990. *Technology for Wasteland Development*. ICAR, New Delhi.
- Andriessse 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.

Course Outcome:

- CO 1. Memorize soil management to sustainable agriculture.
- CO 2. Outline and summarize climate and soil as critical factors in agriculture.
- CO 3. Experience on the knowledge of soil resources on research for solving field problems.
- CO 4. Planning for soil conservation.

PPSE-607: Clay Mineralogy

Credits:04

Objective

Students will learn about soil clay minerals, basic concepts of clay mineralogy and utility in soil research.

Unit I

Definition and concepts of clays and clay minerals, Fundamentals of crystallography – unit cell, external characteristics of crystals, crystallographic notations, crystal systems.

Unit II

Structures and classification of silicate minerals, basics of phyllosilicates, laws governing structural characteristics of phyllosilicates, Goldschmidt's laws – Laws I and Law II, Classification of Phyllosilicates.

Unit III

Kaolinite group of minerals, Dioctahedral kaolins and Trioctahedral kaolins.

Unit IV

Smectites; properties of smectites, Reference models of structure, principal types based on Hofmann-Marshall-Hendricks (H-M-H) models, occurrence of smectites, transformation and formation in soils.

Unit V

Micas: occurrence and origin in soils, polytypes of micas, structure and formation of muscovites and illite.

Unit VI

Vermiculites: structure, occurrence in soils, formation, relation between vermiculites and montmorillonite.

Unit VII

Chlorite: occurrence and structure of chlorites, “swelling chlorites”, formation of chlorite.

Unit VIII

Non-crystalline clays (amorphous materials), subgroups and chemical composition, morphology and structure, physico-chemical properties, influence of non-crystalline clays on soil properties.

Unit IX

Interstratified clay minerals, occurrence and formation in soils, regularly interstratified and partially random interstratified minerals.

Unit X

Genesis and transformation of clay minerals, Generalized conditions for formation and persistence of common clay-size minerals in soils.

Unit XI

Surface chemistry of clay minerals, clay-organic complexes, nanoclay mineralogy.

Unit XII

Clay minerals in different soil orders, role of clay minerals in soil fertility management.

Practical

- Separation of clay for mineralogical study
- X-ray diffraction analysis of clay
- Selective dissolution of clay minerals
- IR, DTA and SEM of clay minerals
- Identification and quantification of clay minerals
- Determination of surface charge of clay minerals
- Potentiometric titration of clay minerals.

Suggested Readings

- Dixon JB and Weed SB (Co-editors). *Minerals in Soil Environment*.
- Gieseking JE (Ed). *Soil Component*, Vol. 2. Inorganic Components.
- Grim RE. *Clay Mineralogy*.
- Mukherjee SK and Biswas TD (Editors). *Mineralogy of Soil Clays and Clay Minerals*.
- Read HH. *Rutley's Elements of Mineralogy*.
- Wilding LP and Smeck NE. 1983. *Pedogenesis and Soil Taxonomy Part II – Soil Orders*.

Course Outcome:

CO1. Define the basic concepts of clay minerals.

CO2. Understanding genesis and transformation of clay minerals.

CO3. Understanding effects of clays on soil properties.

CO4. Experience on soil clays and utility in soil research..

PPSE 608: Recent Trends in Soil Microbial Biodiversity Credits:04

Objective

This course is designed to provide students with an in-depth understanding of soil microbial biodiversity. Students will learn about soil health influenced by soil microbial ecosystem.

Theory

Unit I

Microbial evaluation and biodiversity, Microbial communities in ecosystems, New insights in below ground diverse of plant performance.

Unit II

Qualitative ecology of microorganisms; Biomass and activities.

Unit III

Nitrogen fixing organisms, Trends in diversity of N fixing organisms. Molecular approaches in characterising N fixing microorganisms.

Unit IV

Serology and molecular characterization, ecological aspects of bio determination, soil waste and water management

Unit V

Biodegradability, testing and monitoring of the bioremediation of xenobiotic pollutants and bacterial fertilizers.

Practical

- Determination of soil microbes using classical techniques.
- Determination of soil microbial diversity using molecular techniques.
- Estimation of soil microbial biomass carbon, nitrogen and phosphorus.
- Estimation of key soil enzyme activities.
- Community level physiological profiling of microbial diversity.

Suggested Readings

- 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*.

Course Outcome:

CO1. Knowledge of soil microbial eco-system.

CO2. Analyzing soil microbial biomass in relation to soil fertility.

CO3. Understanding the effect of soil microbial diversity on soil health.

CO4. Experience on soil microbial diversity and planning for proper utilization.