Course Title with Credit Load
Ph.D. in Soil Science

Course Code	Course Title	Credit Hours
Soil 601	Recent trends in soil physics	2+0
Soil 602	Modern concept in soil fertility	2+0
Soil 603*	Physical chemistry of soil	2+0
Soil 604*	Soil genesis and micromorphology	2+0
Soil 605	Bio-chemistry of soil organic matter	2+0
Soil 606	Soil resource management	3+0
Soil 607	Modelling of soil plant system	2+0
Soil 608	Clay Mineralogy	2+1
Soil 609	Recent trends in soil microbial biodiversity	2+1
Soil 691	Doctoral seminar	1+0
Soil 692	Doctoral seminar	1+0
Soil 699	Doctoral Research	-75

*Indicates Core Courses which are Compulsory for PhD Programme

Course Curriculum of Ph.D.

Programme

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

Ph.D. (Ag.) IN SOIL SCIENCE

SEMESTER-I

SHRI VAISHNAV INSTITUTE OF AGRICULTURE, INDORE

SHRI VAISHNAV VIDYAPEETH VISHWAVIDYALAYA, INDORE

	Ph. D. course work- Agriculture (Soil Science)		
	Semester I		
Common courses			
No.	**Course code**	**Course code**	**Credit hours**
1.	PHDA101	Research Methodology	3
2.	PHDA102	Review of Literature	2
3.	PHDA103	Computer Applications	2
4.	PHDA104	Research and Publication Ethics (RPE)	2
5.	PHDSOIL601*	Recent trends in soil physics	2
6.	PHDSOIL602*	Modern concept in soil fertility	2
7.	PHDAGRON 601#	Current trends in Agronomy	3
8.	PHDSTAT 521$	Applied Regression Analysis	3
9.	PHD-S-691£	Doctoral Seminar I	1
10.	PHD-D-101 £*	Dissertation (Doctoral Research)	3
		Total Credits	**23**

	Ph. D. course work- Agriculture (Soil Science)		
	Semester II		
Common courses			
1.	PHDSOIL603*	Physical chemistry of soil	2
2.	PHDSOIL604*	Soil Genesis and Micromorphology	2
3.	PHDSOIL605*	Biochemistry of soil organic matter	2
4.	PHDSOIL606*	Soil resource management	3
5.	PHDAGRON606#	Soil Conservation and Watershed Management	3
6.	PHDSTAT 522$	Data Analysis Using Statistical Packages	3
7.	PHD-S-692 £	Doctoral Seminar II	1
8.	PHD-D-699 £*	Dissertation (Doctoral Research)	4
		Total Credits	**20**

Symbol	**Course**	**Minimum Credit**
*	Major	12
#	Minor	6
$	Supporting	5
£	Seminar	2
£*	Dissertation	75

| 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
PHDAS 101	**Research Methodology**	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.

A1. Research Methodology (PHDAS 101)

Module 1: Introduction to Research Methods: Role and objectives of business research, types of research and various research design (exploratory, descriptive, experimental and diagnostic research), research process: Overview, Problems encountered by researcher. Experimental research design will comprise of Completely Randomized Design, Latin Square Design and Factorial Design. Limitations of RM: Ethics in Research, Philosophical issues in Research.

Module 2: Data and their Collection: Collection, Organization, Presentation, Analysis and Interrelation of Primary and Secondary Data. Measurement in research, measurement scales, sources of errors in measurement, Techniques of developing measurement tools, classification and testing (reliability, verification and validity) scales, Designing questionnaires and interviews Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors.

Module 3: Probability Theory in research: General concepts of probability theory, Discrete and continuous random variables, Different probability distributions, Introduction to discrete time Markov chain and continuous time Mai'kov chain. Hypothesis formulation and Testing: Null &Research. Parametric Tests. Regression Analysis. Simulation in research; Meaning of Simulation, Need of simulation. Appropriateness of simulation, Its advantages and disadvantages. Its applications in engineering, Simulation of queuing systems.

References

- Bryman, Allan and Bell Emma **(2003). Business Research Methods.** Noida: Oxford.
- Kothari, C. R. (2004). **Research Methodology: Methods and Techniques**. New Delhi: New Age International.
- Banks, J.; Carson, J.C. Nelson, B. L.; Nicol, D.M. (2006). **Discrete Event System Simulation.** New Delhi: Prentice Hall.
- Trivedi, R.S. (2002). **Probability and Statistics with Reliability, Queuing and Computer Science Applications.** New York: John Wiely
- Krishanaswamy, K.N. Sivakumar, AppaIyer and Mathiranjan M. (2006). **Management Research Methodology: Integration of Principles, Methods and Techniques.** New Delhi: Pearson Education.

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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
PHDA 102	**Review of Literature**	00	00	00	60	40	2	0	2

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

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

A.2. Review of Literature (PHDA 102)

Course Overview: *The objective of this course is to help the candidate to comprehend his/her broad field of research and be academically sound to carry out his research work. Understand the basic philosophical assumptions underlying research literature reviews for different purposes, including what, why, when, for whom, and how? Be able to manage the process of conducting a literature review, including reading, note taking strategies, coding/reference management, synthesizing and writing literature results. Be able to write a quality literature review with variations in references*

Examination Scheme:

The candidate is required to write a Review paper based on the review of literature on his/her area of research in consultation with his supervisor. The paper has to be evaluated and approved by the panel constituted by Faculty of Doctoral studies and Research besides the assignments.

Course Content

Module 1: **Understanding Review of literature:** Relevance, Approach and Applications; Developing an outline for the literature review; Formulate key questions for a review. Organizing a literature search**:** Identify which literature bases to search; Developing the theoretical basis for the Research Question; Searching for, locating and organizing relevant professional literature

Module 2: **Conducting the Review:** Abstract relevant information from appropriate studies in a systematic manner; critically reviewing the literature; Rate the scientific quality of each study and the level of evidence for each question;

Module 3: **Synthesizing the Review:** Create evidence tables and summary tables; interpret the pattern of evidence in terms of strength and consistency; Summarize the studies' findings. Writing the review: Writing a first draft; Writing references and citations; Obtaining, giving, and making productive use of feedback; the redrafting process; Professional formatting.

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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
PHDA 103	Computer Applications	00	00	00	60	40	2	0	2

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

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

A.3. Computer Applications (PHDA 103)
Course Overview: *The candidate should gain sufficient practical knowledge for use of computer and computer software for use in research work.*

Examination Scheme:
The faculty member will award internal marks out of 40 based on the assignments and minor project. The end semester examination will be 60 marks with weightage of (online exams 40% + practical 60%)

Contents
Module 1: Basic knowledge of application software's in MS- Office with focus on MS-Word- its features and applications related to presentation of text in decent format and saving the same for further use. The practical knowledge of this software should enable the candidate to type and prepare the thesis in a presentable format.MS-Excel- construction of worksheet and inserting data according to its characteristics, use of statistical tools and their presentation in the form of charts and graphs.

Module 2: Use of Internet for research work and exploring various websites and search engines for collecting quality literature review and secondary data etc. related to thesis work.

Module 3: MS- Power point – create power point presentation on a topic related to the theme of thesis and use of different presentation techniques. Use of SPSS – method of preparing data sheet and entering data according to its characteristics , use of various statistical tools on SPSS.

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Course Code	Course Name	TEACHING & EVALUATION SCHEME					Credits		
		Theory			Practical				
		END SEM University Exam	Mid term exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	L	P	Total
PHDA 104	**Research and Publication Ethics (RPE)**	60	00	40	00	00	2	0	2

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

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

A. 4. Research and Publication Ethics (RPE) PHDA 104

Module 1: Philosophy And Ethics-Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments 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

Module 2: 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 behavior and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
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 Suggested, etc.

Module 3: 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 **Tumitin, Urkund And Other Open Source Software Tools. Data Bases 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, SIR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics

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
PHDSOIL 601	**Recent trends in Soil Physics**	60	00	40	00	00	2	0	2

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

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

Objective

To provide knowledge of modern concepts in soil physics.

Theory

UNIT I

Soil-water interactions, soil water potential, free energy and thermodynamic basis of potential concept, chemical potential of soil water and entropy of the system, soil-plant-atmospheric continuum (SPAC).

UNIT II

Fundamentals of fluid flow, Poiseuilles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated waterflow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional waterflow.

UNIT III

Theories of horizontal and vertical infiltration under different boundary conditions. Movement of salts in soils, models for miscible-immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations; break-through curves. Soil air and aeration, mass flow and diffusion processes; thermal properties of soil, heat transfer in soils, differential equation of heatflow, measurement of thermal conductivity of soil; Soil, Plant, Water relations- Plant uptake of soil moisture, Water balance and energy balance in the field; irrigation and water use efficiency.

UNIT IV

Soil crust and clod formation; structural management of puddled rice soils; soil conditioning-concept, soils conditioners-types, characteristics, working principles, significance in agriculture

UNIT V

Solar and terrestrial radiation measurement, dissipation and distribution in soilcrop systems; prediction of evapotranspiration using aerodynamic and canopy temperature-based models; canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infrared thermometer.

Teaching methods/activities

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

Learning outcome

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

Suggested Reading

• Baver LD, Gardner WH and Gardner WR. 1972. Soil Physics. John Wiley & Sons.
• Hanks and Ascheroft. 1980. Applied Soil Physics. Springer Verlag
• Hillel D. 1980. Applications of Soil Physics. Academic Press.
• Hillel D. 1980. Environmental Soil Physics. Academic Press.
• Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.

- Kirkham D and Powers WL. 1972. Advanced Soil Physics. Wiley Interscience.
- Lal R and Shukla MK. 2004. Principles of Soil Physics. Marcel Dekker.
- Oswal MC. 1994. Soil Physics. Oxford & IBH

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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
PHDSOIL 602	**Modern Concept in Soil Fertility**	60	00	40	00	00	2	0	2

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

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

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT I

Nutrient availability-concept and relationships, modern concepts of nutrient s availability; soil colloids and nutrient availability; soil amendments and availability maintenance of nutrients, soil solution and plant growth; nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils. Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils; Kinetic studies of nutrients in soils.

UNIT III

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting. Modernconcepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT IV

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

UNIT V

Carbon– a nutrient central to soil fertility; carbon cycle in nature, stocks, pools and fluxes; greenhouse effect and climate change; carbon sequestration vis-à-vis sustenance of soil quality and crop productivity.

Teaching methods/activities

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

Learning outcome

Experience on the knowledge of soil fertility and fertilizers in relation to plant growth and development.

Suggested Reading

• Barber SA. 1995. Soil Nutrient Bioavailability. John Wiley & Sons.

• Barker V Allen and Pilbeam David J. 2007. Handbook of Plant Nutrition. CRC / Taylor & Francis.

• Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Educ. • Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood & Sons.

• Epstein E. 1987. Mineral Nutrition of Plants - Principles and Perspectives. International Potash Institute, Switzerland.

• Kabata- Pendias Alina 2001. Trace Elements in Soils and Plants. CRC / Taylor & Francis.

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

• Mortvedt JJ, Shuman LM, Cox FR and Welch RM. (Eds.). 1991. Micronutrients in Agriculture. 2nd Ed. Soil Science Society of America, Madison.

• Prasad R and Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.

• Stevenson FJ and Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons.

• Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison.

• Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1990. Soil Fertility and Fertilizers. 5th Ed. Macmillan Publ.

• Wild A. (Ed.). 1988. Russell's Soil Conditions and Plant Growth. 11th Ed. Longman.

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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
PHDAGRON 601	**Current Trends in Agronomy**	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 acquaint the students about recent advances in agricultural production.

Theory

UNIT I

Agro-physiological basis of variation in yield, recent advances in soil plant-water relationship.

UNIT II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures and ITK in organic farming.

UNIT III

Crop residue management in multiple cropping systems; latest developments in plant management Mechanization in crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy. Conservation agriculture, principles, prospects and importance, potential benefits of CA under climate change scenario, policy issues

Teaching methods/activities

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

Learning outcome

Recent advances in agricultural production

Suggested Reading

• Agarwal RL. 1995. Seed Technology. Oxford & IBH.

• Dahiya BS and Rai KN. 1997. Seed Technology. Kalyani.

• Govardhan V. 2000. Remote Sensing and Water Management in Command Areas: Agroecological Prospectives. IBDC.

• ICAR. 2006. Hand Book of Agriculture. ICAR.

• Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.

• Palaniappan SP and Annadurai K. 2006. Organic Farming - Theory and Practice. Scientific Publ. • Sen S and Ghosh N. 1999. Seed Science and Technology. Kalyani.

• Tarafdar JC, Tripathi KP and Kumar M. 2007. Organic Agriculture Scientific Publ.

• Kumar, R, Swarnkar KS, Singh KS and Narayan S. 2016. A Text Book of Seed Technology. Kalyani Publication.

• Reddy SR and Prabhakara G. 2015. Dryland Agriculture. Kalyani Publishers.

• Gururajan B, Balasubhramanian R and Swaminath V. 2013. Recent Strategies on Crop Production. Kalyani Publishers.

• Venkateswarlu B and Shanker Arun K. 2009. Climate change and agriculture: Adaptation and mitigation strategies. Indian Journal of Agronomy 54(2): 226-230

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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
PHDSTAT 521	**Applied Regression Analysis**	60	00	20	15	05	2	1	3

1. Legends: L - Lecture**; P –** Practical
2. *Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

Aim of the course
This course is meant for students of all disciplines including agricultural and animal sciences. The students would be exposed to the concepts of correlation and regression. Emphasis will be laid on diagnostic measures such as autocorrelation, multi collinearity and heteroscedasticity. This course would prepare students to handle their data for analysis and interpretation.

Theory
Unit I
Introduction to correlation analysis and its measures, Correlation from grouped data, correlation, Rank correlation, Testing of population correlation coefficients; Multiple and partial correlation coefficients and their testing.
Unit II
Problem of correlated errors; Auto correlation; Heteroscedastic models, Durbin Watson Statistics; Removal of auto correlation by transformation; Analysis of collinear data; Detection and correction of multi collinearity, Regression analysis; Method of least squares for curve fitting; Testing of regression coefficients; Multiple and partial regressions.
Unit III
Diagnostic of multiple regression equation; Concept of weighted least squares; regression equation on grouped data; Various methods of selecting the best regression equation.
Unit IV
Concept of nonlinear regression and fitting of quadratic, exponential and power curves; Economic and optimal dose, Orthogonal polynomial.

Practical
• Correlation coefficient, various types of correlation coefficients, partial and multiple, testing of hypotheses;
• Multiple linear regression analysis, partial regression coefficients, testing of hypotheses, residuals and their applications in outlier detection;
• Handling of correlated errors, multi collinearity;

• Fitting of quadratic, exponential and power curves, fitting oforthogonal polynomials.

Suggested Reading

• Kleinbaum DG, Kupper LL, Nizam A. 2007. Applied Regression Analysis and Other Multivariable Methods (Duxbury Applied) 4th Ed.
• Draper NR and Smith H. 1998. Applied Regression Analysis. 3rd Ed. John Wiley.
• Ezekiel M. 1963. Methods of Correlation and Regression Analysis. John Wiley.
• Koutsoyiannis A. 1978. Theory of Econometrics. MacMillan.
• Kutner MH, Nachtsheim CJ and Neter J. 2004. Applied Linear Regression Models. 4th Ed. With Student CD. McGraw Hill.

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