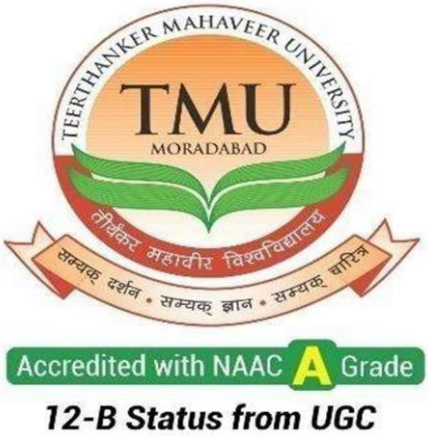
Ph.D. in Agronomy

Re-Structured syllabus as BSMA recommendations 2021-22

[Applicable w.e.f. Academic Session 2024-2025]



TEERTHANKER MAHAVEER UNIVERSITY

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www.tmu.ac.in

Study & Evaluation Scheme

SUMMARY	
Institute Name	Teerthanker Mahaveer University College of Agriculture Sciences
Program	Ph.D. in Agronomy
Duration	Three years full time (Six Semesters)
Medium	English
Credits	
Minimum Credits Required for Degree	105

About The Program

The Ph.D. in Agronomy is a meticulously designed three-year program aimed at providing advanced knowledge and research skills in crop production, soil management, and sustainable agriculture. This program, structured according to ICAR guidelines, typically spans six semesters, depending on the student's progress and institutional requirements. The curriculum covers a comprehensive range of different topics. Students will delve into the interactions between crops and their environment, nutrient cycles, soil fertility, and sustainable farming practices, equipping them with the expertise needed to address complex agricultural challenges.

A significant component of the Ph.D. program is practical training, which prepares students for both laboratory research and fieldwork. This includes hands-on experience in experimental design, data analysis, soil and water testing, and the implementation of crop management practices in real-world settings. Students will learn advanced techniques in molecular biology, microbiology, and biotechnology, gaining practical skills in disease control, soil conservation, and water management. Additionally, the program offers opportunities for students to engage in workshops and seminars with experts, enabling them to present their research, network with professionals, and stay updated on the latest advancements in agronomy.

Students of the Ph.D. in Agronomy program are well-prepared for a variety of careers in academia, research institutions, government agencies, and the private sector. They can pursue roles as university professors, research scientists, agronomists, and policy advisors. The program not only advances students' understanding of plant health and disease prevention but also provides opportunities to contribute significantly to food security and sustainable agriculture through cutting-edge research and innovation. The Ph.D. in Agronomy is a challenging yet rewarding program that equips students with the knowledge and skills needed to make substantial contributions to the field of agriculture.

Program Outcomes (POs)

The Program Outcomes (POs) for a Ph.D. in Agronomy typically encompass a range of advanced skills and knowledge areas that students are expected by the completion of their program. These POs include:

PO1	Graduates will acquire deep expertise in advanced agronomy concepts, enabling them to contribute to sustainable agricultural practices.
PO2	Graduates will develop the ability to design, conduct, and analyze original research, addressing complex issues in agronomy with rigorous methodologies.
PO3	Graduates will be skilled in creating innovative solutions to agronomic challenges, focusing on enhancing crop productivity, soil health, and sustainable resource use.
PO4	Graduates will adhere to high ethical standards in all aspects of research and professional practice, including maintaining integrity and respect for the environment.
PO5	Graduates will be proficient in effectively communicating complex agronomic ideas and research findings to both scientific peers and broader audiences.
PO6	Graduates will demonstrate leadership abilities and collaborate effectively within diverse teams, contributing to advancements in agronomy.
PO7	Graduates will understand the global implications of agronomy, working towards solutions that address food security, environmental sustainability, and societal needs.
PO8	Graduates will commit to continuous learning and professional development, staying updated with the latest trends and innovations in agronomy.

SEMESTER-WISE COURSE STRUCTURE
Ph.D. in Agronomy

Semester- I

S.No.	Course Code	Category	Title of course	L	P	Credit	Min Qualifying Marks	Max Marks
1	RRMD101*	Supporting Course	Research Methodology	4	0	4	60	100
2	RRMD102*	Supporting Course	Quantitative Methods & Computer Applications	2	0	2	60	100
3	RMGT171*	Supporting Course	Review of Literature**	2	0	2	-	-
4	CPE-RPE101*	Supporting Course	Research & Publication Ethics	2	0	2	60	100
5	PDS240149	Major	Current Trends in Agronomy	3	0	3	60	100
Total				13	0	13	240	400

- ***University common supporting course work.**
- **** Prepare title and review for gap in research**

Semester- II

S.No.	Course Code	Category	Title of course	L	P	Credit	Min Qualifying Marks	Max Marks
1	PDS240150	Major	Recent trends in crop growth and productivity	2	2	3	60	100
2	PDS240151	Major	Irrigation management	1	2	2	60	100
3	PDS240152	Major	Recent trends in weed management	2	0	2	60	100
4	PDS240153	Major	Research and Publication ethics	2	0	2	60	100
5	PDS240154	Minor	Modern concept in soil fertility	2	0	2	60	100
6	PDS240155	Minor	Physical chemistry of Soil	2	0	2	60	100
7	PDS240156	Minor	Biochemistry of Soil organic matter	2	0	2	60	100
Total				13	4	15	420	700

III Semester

Sl. No.	Course Code	Category Major	Title of course	L	P	Credit	Evaluation Scheme
1	PDS240157	Major	Seminar	-	-	1	Satisfactory/Non-Satisfactory
2	PDS240158	Major	Thesis Research	-	-	15	Satisfactory/Non-Satisfactory
Total:				**-**	**-**	**16**	-

IV Semester

Sl. No.	Course Code	Category Major	Title of course	L	P	Credit	Evaluation Scheme
1	PDS240157	Major	Seminar	-	-	1	Satisfactory/Non-Satisfactory
2	PDS240158	Major	Thesis Research	-	-	20	Satisfactory/Non-Satisfactory
Total:				**-**	**-**	**21**	-

V Semester

No.	Course Code	Category	Title of course	L	P	Credit	Evaluation Scheme
1	PDS240158	Major	Thesis Research	-	-	20	Satisfactory/ Non-Satisfactory
Total:				**-**	**-**	**20**	-

VI Semester

No.	Course Code	Category	Title of course	L	P	Credit	Evaluation Scheme
1	PDS240158	Major	Thesis Research	-	-	20	Satisfactory/ Non-Satisfactory
Total:				**-**	**-**	**20**	-

Framework of the courses

Major courses: From the Discipline in which a student takes admission.
Minor courses: From the subjects closely related to a student's major subject
Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence.

Breakup of Courses

Sr. No.	Category	Total minimum number of credits to be earned
1	Major Courses	12
2	Minor	6
3	Supporting	10
4	Seminar	2
5	Research & Thesis	75
Total		**105**

List of Major Courses					
Course Code	**Title of course**	**L**	**T**	**P**	**Credit**
PDS240149	Current Trends in Agronomy	3		0	3
PDS240150	Recent trends in crop growth and productivity	2		2	3
PDS240151	Irrigation management	1		2	2
PDS240152	Recent trends in weed management	2		0	2
PDS240153	Research and Publication ethics	2		0	2
PDS240157	Seminar	0	0	2	2
PDS240158	Thesis Research	0	0	0	75

List of Supporting Courses						
No.	**Course Code**	**Title of course**	**L**	**T**	**P**	**Credit**
1	RRMD101	Research Methodology	4	0	0	4
2	RRMD102	Quantitative Methods & Computer Applications	2	0	0	2
	RMGT171	Review of Literature	2	0	0	2
	CPE-RPE101	Research & Publication Ethics	2	0	0	2

List of Minor Courses						
1	PDS240154	Modern concept in soil fertility	2		0	2
2	PDS240155	Physical chemistry of Soil	2		0	2
3	PDS240156	Biochemistry of Soil organic matter	2		0	2

SYLLABUS

Current Trends in Agronomy

Course type	Course code	L T P C
Major	PDS240149	3 0 0 3

Course Outcomes (COs).

On completion of the course the students will be-

CO-1	Students will be familiar with cutting-edge technologies and innovations in agronomy, such as precision agriculture, drones, satellite imaging, and artificial intelligence.
CO-2	Students will understand current trends and best practices in sustainable agriculture, including organic farming, regenerative agriculture, and climate-resilient agriculture.
CO-3	Students will be aware of the global food security challenges and understand how current trends in agronomy can address these issues, including crop yield improvement, water management, and soil conservation.
CO-4	Students will learn to apply data-driven decision making in agronomy, using tools and techniques such as data analytics, machine learning, and geospatial analysis to optimize crop management and improve agricultural productivity.

Theory

Unit I **(5 Hours)**

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

Unit II **(5 Hours)**

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 **(5 Hours)**

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 **(5 Hours)**

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 **(5 Hours)**

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.

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.

Recent Trends in Crop Growth and Productivity

Course Type	Course Code	L T P C
Major	PDS240150	2 0 2 3

Course Outcomes (COs).

On completion of the course the students will be-

CO1	Understanding the fundamentals crop growth and their productivity
CO2	Apply the knowledge about maximizing solar energy utilization in crop growth
CO3	Analyze the growth analysis of crops
CO4	Evaluate the productivity trend in irrigated and un-irrigated areas

Unit I **(4 Hours)**

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

Unit II **(4 Hours)**

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

Unit III **(4 Hours)**

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

Unit IV **(4 Hours)**

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

1. Field measurement of root-shoot relationship in crops at different growth stages
2. Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at Physical Sciences: Agronomy 67 different stages of crop growth
3. Computation of harvest index of various crops

4. Assessment of crop yield on the basis of yield attributing characters
5. Construction of crop growth curves based on growth analysis data
6. Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping • Senescence and abscission indices
7. Analysis of productivity trend in un-irrigated areas
8. Analysis of productivity trend in irrigated areas

Suggested Reading

1. Chopra VL and Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford & IBH.
2. Delvin RM and Vitham FH. 1986. Plant Physiology. CBS Publ.
3. Evans LT. 1975. Crop Physiology. Cambridge Univ. Press.
4. Evans LT. 1996. Crop Evolution, Adaptation and Yield. Cambridge Univ. Press.
5. Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH.
6. Gupta US. 1988. Progress in Crop Physiology. Oxford & IBH.
7. Kramer PJ and Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press.
8. Mukherjee S and Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill.
9. Narwal SS, Politycka B and Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Pub. • Tiaz L. and Zeiger E. 2006. Plant Physiology. Sinauer Associates, Inc.

Irrigation Management

Course type	**Course code**	**L T P C**
Major	PDS240151	1 0 2 2

Course Outcomes (COs).

On completion of the course the students will be-

CO-1	Students will be able to calculate crop water requirements, understand water balance concepts, and determine optimal irrigation schedules.
CO-2	Students will learn to design, evaluate, and optimize irrigation systems, including sprinkler, drip, and flood irrigation systems, considering factors like soil type, topography, and water source.
CO-3	Students will understand strategies for water conservation and efficiency in irrigation, such as precision irrigation, soil moisture monitoring, and water harvesting.
CO-4	4. Students will learn to apply remote sensing and GIS technologies to analyze and manage irrigation systems, including crop stress detection, soil moisture mapping, and water resource planning.

Theory

Unit I **(5 Hours)**

Global water resources; Water resources of India, irrigation projects during pre and post independence period and their significance in crop production; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth. Movement of water in soil-water movement under saturated and unsaturated conditions, Poiseulle's and Darcy's law, general equation of saturated and unsaturated flow of water in soil.

Unit II **(5 Hours)**

Soil-plant-water relationships, evaporation, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity. Water requirement, irrigation needs, factors affecting irrigation need; water use efficiency, Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops. Soil and plant water potential, SPAC, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, factors affecting ET, control of ET b mulching and use of anti-transpirents; fertilizer use in relation to irrigation.

Unit III **(5 Hours)**

Crop water stress – water deficits and crop growth, adoptability to the crops. Water availability with relation to nutrient availability. Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

Unit IV **(5 Hours)**

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

Unit V **(5 Hours)**

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation. Economic analysis of irrigation and cop planning for optimum use of irrigation water. Crop water production function

Practical

- Determination of water infiltration characteristics and water holding capacity of soil profiles.
- Determination Moisture extraction pattern of crops
- Determination of water balance component of transplanted rice by drum culture technique
- Determination of consumptive use and water requirement of a given cropping pattern
- Determination of crop efficient of one important crop
- Planning, designing and installation of drip irrigation system
- Planning, designing and installation of sprinkler irrigation system
- Designing of drainage channel
- Measurement of irrigation efficiencies
- Determination of irrigation timing under different methods of irrigation
- Visit to irrigation command area

Suggested Reading

- MP. Singh 2017. Recent advances in Irrigation water management. Kalyani Publishers
- FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.
- Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
- Mishra RR and Ahmad M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH.

- Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
- Reddy SR. 2000. Principles of Crop Production. Kalyani.
- Sankara Reddy GH and Yellamananda Reddy. 1995. Efficient Use of Irrigation Water In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.
- Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US.(Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH

Recent Trends in Weed Management

Course type	Course code	L T P C
Major	PDS240152	2 0 0 2

Course Outcomes (COs).

On completion of the course the students will be-

CO-1	Students will comprehend the latest research on weed biology, ecology, and evolution, including weed-crop interactions, seed banks, and invasive species.
CO-2	Students will learn about IWM approaches, combining physical, cultural, biological, and chemical controls to manage weeds effectively and sustainably.
CO-3	Students will understand precision weed management technologies, including precision spraying, drones, and satellite imaging, to optimize weed control and reduce herbicide use.
CO-4	Students will be aware of the growing issue of herbicide resistance and learn about alternative solutions, such as non-chemical controls, biological control agents, and novel herbicide formulations.

Theory

Unit I **(5 Hours)**

Crop-weed competition in different cropping situations; changes in weed flora, various causes and effects; different methods of weed management. Migration, introduction adaptation of weeds, Invasive weeds – biology and management. Different mechanisms of invasion – present status and factors influencing weed invasion.

Unit II **(5 Hours)**

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

Unit III **(5 Hours)**

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, Degradation of herbicides in soil and plants- factors affecting it, primary and secondary metabolites, residue management of herbicides, adjuvants.

Unit IV **(5 Hours)**

Advances in herbicide products and application techniques and methods; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides; herbicide rotation and herbicide mixtures. Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

Unit V **(5 Hours)**

Relationship of herbicides with tillage, fertilizer, and irrigation, cropping system; bioherbicides, allelochemical and alleloherbicides, herbicide bioassays. Recent advances in nonchemical weed management including deleterious rhizobacteria, robotics, biodegradable film, etc.

Suggested Reading

- Böger, Peter, Wakabayashi, Ko, Hirai, Kenji (Eds.). 2002. Herbicide Classes in Development. Mode of Action, Targets, Genetic Engineering, Chemistry. Springer.
- Das TK. 2008. Weed Science: Basics and Applications, Jain Brothers (New Delhi)
- Fennimore, Steven A and Bell, Carl. 2014. Principles of Weed Control, 4th Ed, California Weed Sci. Soc.
- Gupta OP. 2007. Weed Management: Principles and Practices, 2nd Ed.
- Jugulan M, (ed). 2017. Biology, Physiology and Molecular Biology of Weeds. CRC Press.

Research and Publication Ethics

Course type	Course code	L T P C
Major	PDS240153	2 0 0 2

Course Outcomes (COs).

On completion of the course the students will be-

CO-1	Students will comprehend the fundamental ethical principles guiding research, including honesty, objectivity, integrity, and respect for participants and colleagues.
CO-2	Students will learn about publication ethics, including authorship, plagiarism, data falsification, and peer review processes, to ensure responsible dissemination of research findings.
CO-3	Students will understand the types of research misconduct, such as fabrication, falsification, and plagiarism, and their consequences, including retractions, reputational damage, and legal issues.
CO-4	4. Students will develop skills to apply ethical decision-making frameworks to real-world research scenarios, ensuring responsible conduct of research and maintaining the integrity of the scientific record.

Theory

Unit I **(5 Hours)**

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- falsifications, fabrications and plagiarism (FFP): Redundant publications: duplicate and overlapping publications, salami slicing; selective reporting and misrepresentation of data

Unit II **(5 Hours)**

Publication ethics: Defination, introduction and importance. Best practices/standard setting initiatives and guidelines: COPE, WAME, etc., conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, type, violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, predatorypublishers and journals

Unit III **(5 Hours)**

Open access publishing: open access publication and initiatives: SHERPA, RoMEO online resource to checkpublisher copy right and selfarchivingpolicies; software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestions tools viz., JANE, Elsevier Journal Finder, Springer Journal Suggesteretc.

Unit IV **(5 Hours)**

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 sourcesoftware tools

Unit V **(5 Hours)**

Database and Research metrics: Indexing data base, citation database, web of science, scopus, etc. Impact factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, g-index, i10-index altmetrics.

Suggested Reading

- Research Ethics in India: Issues and Challenges" by Prof. P.B. Mehta
- Scientific Research and Ethics" by Dr. G. J. V. Jagannadha Raju
- Ethics in Research and Publication" by Dr. G. L. Bhardwaj
- Research Methodology and Ethics" by Dr. C. R. Kothari and Dr. Gaurav Garg.

Modern Concept in Soil Fertility

Course Type	**Course Code**	**L T P C**
Minor	PDS240154	2 0 0 2

Course Outcomes (COs).

On completion of the course the students will be-

CO1	Understanding the modern concept of nutrient availability to plant
CO2	Apply the knowledge about mechanistic approach to nutrient supply and uptake by plants
CO3	Analyze the chemistry of nutrient in submerge soil
CO4	Evaluate the techniques of soil fertility evaluation

Unit I **(6 Hours)**

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 **(4 Hours)**

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.

Unit III **(4 Hours)**

Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged

soils; Kinetic studies of nutrients in soils.

Unit IV **(4 Hours)**

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

Unit V **(6 Hours)**

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

Unit VI **(6 Hours)**

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

Unit VII **(6 Hours)**

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.

Suggested Reading

1. Barber SA. 1995. Soil Nutrient Bioavailability. John Wiley & Sons.
2. Barker V Allen and Pilbeam David J. 2007. Handbook of Plant Nutrition. CRC / Taylor &
3. Francis.
4. Brady NC and Weil RR. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Educ.
5. Cooke GW. 1979. The Control of Soil Fertility. Crossby Lockwood & Sons.
6. Epstein E. 1987. Mineral Nutrition of Plants - Principles and Perspectives. International
7. Potash Institute, Switzerland.
8. Kabata- Pendias Alina 2001. Trace Elements in Soils and Plants. CRC / Taylor & Francis.
9. Kannaiyan S, Kumar K and Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
10. Mortvedt JJ, Shuman LM, Cox FR and Welch RM. (Eds.). 1991. Micronutrients in Agriculture.
11. 2nd Ed. Soil Science Society of America, Madison.
12. Prasad R and Power JF. 1997. Soil Fertility Management for Sustainable Agriculture. CRC
13. Press.
14. Stevenson FJ and Cole MA. 1999. Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur,
15. Micronutrients. John Wiley & Sons.
16. Stevenson FJ. (Ed.). 1982. Nitrogen in Agricultural Soils. Soil Science Society of America,
17. Madison.
18. Tisdale SL, Nelson WL, Beaton JD and Havlin JL. 1990. Soil Fertility and Fertilizers. 5th
19. Ed. Macmillan Publ.
20. Wild A. (Ed.). 1988. Russell's Soil Conditions and Plant Growth. 11th Ed. Longman.

Physical Chemistry of Soil

Course Type	Course Code	L T P C
Minor	PDS240155	2 0 0 2

Course Outcomes (COs).

On completion of the course the students will be-

CO1	Understanding the colloidal chemistry of organic and inorganic components
CO2	Apply the knowledge about thermodynamics of nutrient transformations
CO3	Analyze the adsorption and desorption theory
CO4	Evaluate the electrochemical properties of clays

Unit I **(4 Hours)**

Colloidal chemistry of in organic and organic components of soils–their formation, clay organic interaction.

Unit II **(6 Hours)**

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

Unit III **(6 Hours)**

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 **(6 Hours)**

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

Unit V **(6 Hours)**

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

Suggested Reading

1. Bear RE. 1964. Chemistry of the Soil. Oxford & IBH.
2. Bolt GH and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
3. Fried M and Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition.

Academic Press.

4. Greenland DJ and Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.

5. Greenland DJ and Hayes MHB. 1978. Chemistry of Soil Constituents. John Wiley & Sons.
6. Jurinak JJ. 1978. Chemistry of Aquatic Systems. Department of Soil Science and
7. Biometeorology, Utah State University
8. McBride MB. 1994. Environmental Chemistry of Soils. Oxford University Press.
9. Sparks DL. 1999. Soil Physical Chemistry. 2nd Ed. CRC Press.
10. Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford University Press.
11. Sposito G. 1984. The Surface Chemistry of Soils. Oxford University Press.
12. Sposito G. 1989. The Chemistry of Soils. Oxford University Press.
13. Stevenson FJ. 1994. Humus Chemistry. 2nd Ed. John Wiley.
14. van Olphan H. 1977. Introduction to Clay Colloid Chemistry. John Wiley & Sons

Biochemistry of Soil Organic Matter

Course Type	**Course Code**	**L T P C**
Minor	PDS240156	2 0 0 2

Course Outcomes (COs).
On completion of the course the students will be-

CO1	Understanding the role of organic matter and humus in soil productivity
CO2	Apply the knowledge about biochemistry of the humus formation
CO3	Analyze the Nutrient transformation
CO4	Evaluate the Humus-pesticide interactions in soil, mechanisms.

Unit I **(6 Hours)**

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 **(4 Hours)**

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

Unit III **(4 Hours)**

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

Unit IV **(6 Hours)**

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

Unit V **(4 Hours)**

Humus-pesticide interactions in soil, mechanisms.

Reading Materials

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

Research Methodology
COURSE CODE: RRMD101

1. Scientific Research: meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; constructs and variables- nature of construct and variables, concept of constructs, type of variables, continuous and categorical, constructs, observables and intervening variables; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting.
2. Problem Identification and Hypothesis Formation: problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors.
3. Sampling and Research Design: meaning and types of sampling; probability and non probability sampling. methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, types of research design, criteria of a good research design, basic principles of experimental design.
4. Introduction to MS-Office: MS-WORD, MS-EXCEL, MATLAB, LATEX.

Suggested Reading:

1. Cooper & Schindler, *Business Research Methods*, Tata McGraw Hill.
2. Saunders, *Research Methods for Business Students*, Pearson Education
3. Allen T Harrell, *New Methods in Social Science Researchs*, Praeger Publishers, New York
4. Beri, G.C., S*tatistics for Management*, Tata MacGraw-Hill
5. Chandan J. S., *Statistics for Business and Economics*, Vikas Publications.
6. Broota, K.D., *Experimantal Designs in Behavioural Research*, New Age International
7. Singh A. K., *Test Measurement and Research Methods in Behaviours Sciences*, Bharti Bhawan
8. Joyce Cox & Polly Urban, *Microsoft Office*, Galgotia Publishing
9. Sinha P.K., *Computer Fundamentals*, BPB Publishing.

Quantitative Methods and Computer Applications (RRMD102)

1. Measurement and Scaling Techniques: measurement in research, measurement scales sources of errors in measurement, tests of second measurement, techniques of developing measurement tools, meaning of scaling, scale classification bases, important scaling techniques, and scale construction techniques.
2. Data Collection, Processing and Analysis: methods of data collection – primary data, secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion; correlation and regression analysis - meaning and uses, methods of calculation of coefficients and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.
3. Report Writing: meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application, application of statistical tests/techniques through the use of statistical software like SPSS, scientific packages like LISREL, AMOS, and SYSTAT for documentation and report generation.

Suggested Reading:

1. Cooper & Schindler, *Business Research Methods*, Tata McGraw Hill.
2. Malhotra Naresh K., *Marketing Research*, Pearson Education
3. Power Analysis for experimental Research: A practical Guide for the Biological, Medical and Social Sciences by R. Barker Baushell, Yu-Fang Li Cambridge University Press
4. Chandan J. S., *Statistics for Business and Economics*, Vikas Publications.
5. Broota, K.D., *Experimantal Designs in Behavioural Research*, New Age International
6. Singh A. K., *Test Measurement and Research Methods in Behaviours Sciences*, Bharti Bhawan
7. Joyce Cox & Polly Urban, *Microsoft Office*, Galgotia Publishing
8. Sinha P.K., *Computer Fundamentals*, BPB Publishing.
9. Latex: A Document Preparation System, 2/E pearson low price edition by Lamport
10. MATLAB: An Introduction with Applications by Gilat Wiley India Pvt. Ltd.
11. Getting started with MATLAB by Rudra Pratap Oxford University Press.

EVALUATION OF REVIEW OF LITERATURE (RMGT171)

The research scholar will review the important studies conducted at the national and international level either by individuals or organizations including government agencies and present the methodology adopted and important

findings emerged from these studies. Based on this review of literature the researcher will identify the research gaps existing in the available literature and thus justifying the need for the present study.
The researcher is supposed to follow the pattern adopted in the standard national and international research journals. However, as an illustration the pattern for reporting review of literature is as under:

1. Tiwari and Sinha (1971) gave productivity trends and factor compensation in Indian textiles industry for the period 1946-65 comprising of two sub-periods (1946- 1955 and 1956-1965). The marginal productivity of capital on an average for the industry as a whole is found to be lower in the sub-period (1946-55) and higher during (1956- 65). On the contrary, the estimates of the marginal productivity of labour again on average exhibit an actual decline from 2.9 percent to 2.5 percent.
2. Menon (1971) in his review article examines the concepts associated with measurement of productivity at various dimensions of output and input, which are the major elements involved in the exercise of measuring productivity.
3. Kumar, Anil and Khurana (2007) in their paper have examined trends in productivity of labour and capital in dairy industry in India during pre and post-reform periods. The results in the study conclude that labour productivity at national level has shown considerable improvement during post-reform period. But variations have been observed in case of growth rate of labour productivity at state-level. On the other hand, capital productivity has declined during post-reform period at national and state levels.
4. Kumar and Bala (2007) in their study on "An evaluation of the impact of economic reforms on the growth and productivity of Indian small scale sector" has concluded that economic reforms process initiated in the early nineties has had a downbeat impact on the growth and productivity of small scale sector.

Research & Publication Ethics (CPE-RPE101)

Theory

- **RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)**
    1. Introduction to philosophy: definition, nature and scope, concept, branches
    2. Ethics: definition, moral philosophy, nature of moral judgments and reactions
- **RPE 02: SCIENTIFIC CONDUCT (5 hrs.)**
    1. Ethics with respect to science and research
    2. Intellectual honesty and research integrity
    3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
    4. Redundant publications: duplicate and overlapping publications, salami slicing
    5. Selective reporting and misrepresentation of data
- **RPE 03: PUBLICATION ETHICS (7 hrs.)**
    1. Publication ethics: definition, introduction and importance
    2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

Practice

- **RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)**
    1. Open access publications and initiatives
    2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
    3. Software tool to identify predatory publications developed by SPPU
    4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.
- **RPE 05: PUBLICATION MISCONDUCT (4hrs.)**

Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

Software tools (2 hrs.) :Use of plagiarism software like Tumitin, Urkund and other open source software tools

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

. Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

Research Metrics (3 hrs.)

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