Ph.D. Course Work Common Syllabus

Paper Name: Research Methodology	Paper Code: PHD-101/RM	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	**Internal = 30**	**External = 70**

Course Objectives

1. To introduce the fundamental concepts, methods, and ethics of scientific research.
2. To develop skills in research design, data collection, analysis, and interpretation.
3. To enable students to formulate research problems and communicate findings effectively.

Unit	Contents	Lectures
I	Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.	**10**
II	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.	**10**
III	Sampling: Concepts of Statistical approach, Sample, Sampling Frame, Sampling Error, Sample Size. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	**15**
IV	Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Techniques of Scientific Measurement. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, The art of Scientific Communication.	**12**

V	Use of tools/techniques for Research: methods to search required information effectively, Reference Management Software like Endnote/Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. Presentation in Seminars and Conferences, Sponsored Research-basics, Major funding bodies for research, National- DST, UGC, CSIR, ICMR, DBT, SERB, ISRO, and DRDO, International- NSF, NIH, Horizon Europe and UNESCO.	**13**
	Total	**60**

Suggested Readings

1. Kothari, C. R., and Gaurav Garg. Research Methodology: Methods and Techniques. 4th ed., New Age International Publishers, 2019.
2. Creswell, John W., and J. David Creswell. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 5th ed., SAGE Publications, 2018. https://us.sagepub.com/en-us/nam/research-design/book255675
3. Saunders, Mark, Philip Lewis, and Adrian Thornhill. Research Methods for Business Students. 8th ed., Pearson Education, 2019.
4. Bryman, Alan. Social Research Methods. 5th ed., Oxford University Press, 2016. https://global.oup.com/ukhe/product/social-research-methods-9780199689453
5. Flick, Uwe. An Introduction to Qualitative Research. 6th ed., SAGE Publications, 2018.
6. Walliman, Nicholas. Research Methods: The Basics. 2nd ed., Routledge, 2017. https://www.routledge.com/Research-Methods-The-Basics/Walliman/p/book/9781138693981
7. Kumar, Ranjit. Research Methodology: A Step-by-Step Guide for Beginners. 5th ed., SAGE Publications, 2022.
8. Neuman, W. Lawrence. Social Research Methods: Qualitative and Quantitative Approaches. 8th ed., Pearson, 2014.
9. Research Methods in Psychology. https://www.saylor.org/courses/psych301/
10. https://onlinecourses.nptel.ac.in/noc23_ge36/preview
11. https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Ph.D. Course Work Common Syllabus

Paper Name: Research and Publication Ethics	Paper Code: PHD-102/RPE	Credits: 2 (2-0-0)
Evaluation (Maximum Marks = 100)	Active participation, group discussion and quizzes (25%); Practical: 40%; and End Semester written examination: 35 %	

Introduction:

This course is designed to create awareness among doctoral students about research and publication ethics and different types of unethical practices and misconduct in publications. This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity, publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, Open Access publications, research metrics (citations, h-index, Impact Factor, etc.) and Plagiarism tools will be introduced in this course.

Course Structure

The course comprises of six modules listed in table below. Each module has 4-5 units.

Modules	Unit title	Teaching hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE05	Publications Misconduct	4
RPE 06	Databases and Research Metrics	7
	Total	**30**

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 judgements and reactions

RPE 02: SCIENTIFIC CONDUCT (5hrs.)

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 misrepresentations of data.

RPE 03: PUBLICATION ETHICS (7 hrs.)

1. Publication ethics: definition, introduction and importance
2. Best practices/standards setting initiatives and guidelines: CARE, 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 Tools to Identify Predatory Publications
4. Journal Finder/Journal Suggestion Tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

RPE 05: PUBLICATION MISCONDUCT (4 hrs.)

A. Group Discussions (2 hrs.)

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

B. Software tools (2hrs.)

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

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

A. Databases (4 hrs.)

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

B. Research Metrics (3hrs.)

1 Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPR, Cite Score

2 Metrics: h-index, g-index, i10 index, altmetrics

Essential Readings

- Suber, P. (2012). *Open Access*. Cambridge, MA, USA: MIT Press.
- Resnik, D.B. (2011). What Is Ethics in Research & Why Is it Important. National Institute of Environmental Health Sciences, I-10.
- National Academy of Sciences, National academy of Engineering and Institute of Medicine (2009). *On Being a Scientist: A Guide of Responsible Conduct in Research*: Third Edition, National Academies Press.
- Madalli, D.P. (2015). *Concepts of Openness and Open Access*. UNESCO Curriculum for Researchers, Module 2. Paris: UNESCO.
- MacIntyre, Alasdair (1967). A Short History of Ethics. London.
- Kanjilal, U. & Das, A.K. (2015). *Introduction to Open Access*. UNESCO Curriculum for Library Schools, Module 1. Paris: UNESCO.
- INSA (2019). Ethics in Science Education, Research and Governance, Edited by K. Muralidhar, A. Ghosh, & A.K. Singhvi. New Delhi: Indian National Science Academy. ISBN: 9788193948217.
- Das, A.K. (2015). *Research Evaluation Metrics*. UNESCO Curriculum for Researchers, Module 4. Paris: UNESCO.

- Das, A.K. & Mishra, S. (2014). Genesis of Altmetrics or Article-level Metrics for Measuring Efficacy of Scholarly Communications: Current Perspectives. *Journal of Scientometric Research*, 3(2): 82-92.
- Chaudhari, N. & Baliga, V. (2015). *Intellectual Property Rights*. UNESCO Curriculum for Researchers, Module 3. Paris: UNESCO.
- Chaddah, P. (2018). Ethics in Competitive Research: Do Not Get Scooped; To Not Plagiarized. ISBN: 9789387480865
- Bird, A. (2006). Philosophy of Science. Routledge.

Supplementary Readings

- ICMR (2017). *National Ethical Guidelines for Biomedical and Health Research Involving Human Participants*. New Delhi: Indian Council of Medical Research.
- Indian Sociological Society (2020). *ISS Code of Ethics*. New Delhi: Indian Sociological Society.
- PSA (2019). *Draft National Policy on Academic Ethics*. New Delhi: Principal Scientific Adviser (PSA) to the Government of India.
- The InterAcademy Partnership (2022). *Report: Combatting Predatory Academic Journals and Conferences*. Trieste: The InterAcademy Partnership.
- UGC (2019). *Consortium for Academic Research and Ethics (CARE)*. New Delhi: University Grants Commission.
- UGC (2020). *Good Academic Research Practices*. New Delhi: University Grants Commission.
- UNESCO (2021). *UNESCO Recommendation on Open Science*. Paris: UNESCO.
- Das, A.K. (2008). *Open Access to Knowledge and Information: Scholarly Literature and Digital Library Initiatives - the South Asian Scenario*. New Delhi: UNESCO, ISBN 9788189218218.
- Das, A.K. (2015). *Scholarly Communications*. UNESCO Curriculum for Researchers, Module 1. Paris: UNESCO.
- Das, A.K. (2019). Research Integrity in the Context of Responsible Research and Innovation Framework. *DESIDOC Journal of Library & Information Technology*, 39(2): 82-86.
- Das, A.K. (2020). UNESCO Recommendation on Open Science: An Upcoming Milestone in Global Science. *Science Diplomacy Review*, 2(3): 39- 43.
- Mishra, S. & Das, A.K. (2015). *Sharing your Work in Open Access*. UNESCO Curriculum for Researchers, Module 5. Paris: UNESCO.

- Nisha, F., Das, A.K. & Tripathi, M. (2020). Stemming the Rising Tide of Predatory Journals and Conferences: A Selective Review of Literature. *Annals of Library and Information Studies*, 67(3): 173-182.
- Smith, I. (2015). *Open Access Infrastructure*. UNESCO Curriculum for Library Schools, Module 2. Paris: UNESCO.
- Bealt, J. (2012). Predatory Publishers Are Corrupting Open Access. *Nature*, 489(7415),179-179.

Ph.D. Course Work Common Syllabus

Paper Name: Computer Application	Paper Code: PHD-103/CA	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	**Internal = 30**	**External = 70**

Course Objectives

1. To introduce the fundamental concepts, architecture, and classifications of computers along with operating systems like Windows and Linux.
2. To develop proficiency in using Microsoft Office tools (Word, Excel, PowerPoint) for document preparation, data analysis, and presentations.
3. To familiarize students with internet usage, email communication, and basic networking concepts for effective digital connectivity and communication.

Unit	Contents	Lectures
I	Definition and Characteristics of systems-Hardware & Software, Windows and Linux (Latest Version) Microsoft Tools- Definition and Characteristics of Computers: Classification of Computers; Application of Computers; Hardware; Software; Functional Units of a Computer System; Computer Architecture; Bit, Nibble and Byte. Windows: Introduction to Windows Operating System; Windows Features; Starting Windows; Parts of Windows Screen; Shortcuts in Winodows; Windows Applets; Windows : My Computer; Working with files and Folders; what is MS-DOS? Booting Process; The DOS Directory Structure; Referencing Group of files; Command Syntax; Types of Commands; Microsoft Word (Latest Version): Introduction to Microsoft Tools; Starting Word; Mail Merge.	**15**
II	Microsoft Excel; (Latest Version) Excel Features; Entering data into a Cell; Entering Numbers; Spreadsheets Operations; Freezing Window Panes; Excel Offers Several Methods for Selecting Cells; Erasing the Content of A Cell; Formatting Cells from the Home Tab; The Format Painter; Formulas and Functions; Using Logical Functions; Date and Time Functions; Math and Trigonometric Functions; Statistical Functions; Copying Formulas; Charts; Creating a New Embedded Chart; Type of Charts; Formatting Chart Elements from the Format tab.	**15**
III	Microsoft PowerPoint (Latest Version) What is Presentation? Introduction to PowerPoint; Starting PowerPoint; PowerPoint Views; Save a Presentation; Exiting PowerPoint; Working with Slides.	**10**
IV	Introduction to Internet and E-Mail Hardware requirement; to connect to the Internet; Types of Connections; Internet Service Providers; Internet Addressing; Resource Addressing; The World Wide Web; E-Mail.	**10**
V	Networking Concepts What is a Networks?; Uses of Computer Networks; Network Topologies; Network Hardware and Software.	**10**

	Total	**60**

Suggested Readings

1. Rajaraman, V. Fundamentals of Computers. 6th ed., PHI Learning, 2018.
2. Sinha, P. K., and Priti Sinha. Computer Fundamentals. BPB Publications, 2010.
3. Balagurusamy, E. Programming in ANSI C. 8th ed., McGraw Hill Education, 2019.
4. Forouzan, Behrouz A. Data Communications and Networking. 5th ed., McGraw Hill Education, 2017.
5. Tanenbaum, Andrew S., and Herbert Bos. Modern Operating Systems. 4th ed., Pearson, 2014.
6. Stallings, William. Computer Organization and Architecture: Designing for Performance. 10th ed., Pearson, 2016.
7. Riley, David, and Kenny Hunt. Computational Thinking for the Modern Problem Solver. CRC Press, 2014.
8. Rouse, Margaret Z. Information Technology for Management. Wiley, 2020.
9. Evans, Alan, Kendall Martin, and Mary Anne Poatsy. Technology in Action: Introductory. 15th ed., Pearson, 2019.
10. NPTEL. Computer Science and Engineering, https://nptel.ac.in/course.html
11. GeeksforGeeks. Computer Science Portal for Geeks, https://www.geeksforgeeks.org/
12. Coursera. Computer Science Courses, https://www.coursera.org/browse/computer-science
13. TutorialsPoint. Computer Programming and IT Tutorials, https://www.tutorialspoint.com/index.htm
14. https://nptel.ac.in/courses/106106092

Glocal School of Agricultural Science
Ph.D. Course Work: Elective

Paper Name: Advance Growth in Crop Production	Paper Code: PHD-104/AG (I)	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	**Internal = 30**	**External = 70**

Course Objectives

1. Understand physiological and environmental factors affecting crop growth, yield, and productivity.
2. Analyze concepts such as solar radiation interception, photosynthesis, and growth indices for optimizing resource use.
3. Evaluate intercropping systems, ideotypes, and hormonal regulation in improving crop performance under varied conditions.

Unit	Contents	Lectures
I	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.	**15**
II	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.	**15**
III	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.	**15**
IV	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.	**15**
	Total	**60**

Suggested Readings

1. Radford, B. J., and D. M. McDonald. Crop Physiology: Applications for Genetic Improvement and Agronomy. CABI, 2020.

2. Taiz, Lincoln, et al. Plant Physiology and Development. 6th ed., Sinauer Associates, 2015.
3. Hay, R. K. M., and J. R. Porter. The Physiology of Crop Yield. 2nd ed., Wiley-Blackwell, 2006.
4. Watson, D. J., and M. L. Jackson. Plant and Crop Physiology. Prentice Hall, 2003.
5. Pal, M., and A. K. Ghosh. Crop Physiology. New Central Book Agency, 2012.
6. Singh, B. D., and A. K. Singh. Plant Breeding: Principles and Methods. 11th ed., Kalyani Publishers, 2021.
7. Noggle, G. R., and G. J. Fritz. Introductory Plant Physiology. 2nd ed., Prentice Hall, 1983.
8. Plant Growth Analysis. Plant Physiology Online, University of Hamburg, https://www.biologie.uni-hamburg.de/b-online/e35/35.htm
9. Intercropping and Mixed Cropping. FAO Corporate Document Repository, Food and Agriculture Organization, https://www.fao.org/3/x5560e/x5560e06.htm
10. Solar Radiation and Crop Production. OpenAgri, ICAR eCourse Platform, https://ecourses.icar.gov.in

Glocal School of Agricultural Science
Ph.D. Course Work: Elective

Paper Name: Current Trends in Agronomy	Paper Code: PHD-104/AG (II)	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	**Internal = 30**	**External = 70**

Course Objectives

1. Understand agro-physiological and environmental factors influencing crop yield and soil-plant-water relationships.
2. Analyze recent advancements in sustainable farming systems, including organic, precision, and conservation agriculture.
3. Evaluate global and policy aspects such as WTO, contract farming, marketing, certification, and export of agricultural products.
4. Apply modern technologies like GIS, GPS, remote sensing, and mechanization tools for efficient crop and resource management.

Unit	Contents	Lectures
I	Agro-physiological basis of variation in yield, recent advances in soil-plant-water relationship.	**5**
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.	**15**
III	Crop residue management in multiple cropping systems; latest developments in plant management. Mechanisation in crop production: modern agricultural precision tools and technologies, weed management, cropping systems, grassland management, agro-forestry, allelopathy.	**10**
IV	GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.	**15**
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	**15**
	Total	**60**

Suggested Readings

1. Balasubramaniyan, P., & Palaniappan, S. P. (2016). Principles and practices of agronomy (2nd ed.). Agrobios (India).
2. Tisdale, S. L., Nelson, W. L., Beaton, J. D., & Havlin, J. L. (2002). Soil fertility and fertilizers (5th ed.). Prentice Hall of India.
3. Hillel, D. (2003). Introduction to environmental soil physics. Academic Press.

4. Reddy, S. R. (2016). Principles of crop production. Kalyani Publishers.
5. Gupta, U. S. (2006). Production and improvement of crops for drylands. Oxford & IBH Publishing.
6. Yadav, R. L. (2003). System-based integrated nutrient management. International Potash Institute.
7. Lampkin, N. (1990). Organic farming. Farming Press Books.
8. Srivastava, A. K., Goering, C. E., Rohrbach, R. P., & Buckmaster, D. R. (2006). Engineering principles of agricultural machines (2nd ed.). American Society of Agricultural Engineers.
9. Swaminathan, M. S. (2000). Science and sustainable food security: Selected papers of M.S. Swaminathan. World Scientific.
10. Singh, B. D. (2018). Plant breeding: Principles and methods (11th ed.). Kalyani Publishers.
11. Food and Agriculture Organization (FAO). (n.d.). Sustainable agriculture and food systems. https://www.fao.org/sustainability/en/
12. International Federation of Organic Agriculture Movements (IFOAM). (n.d.). Organic farming resources. https://www.ifoam.bio/
13. Indian Council of Agricultural Research (ICAR). (n.d.). Agricultural research publications and resources. https://icar.org.in/

Glocal School of Agricultural Science
Ph.D. Course Work: Elective

Paper Name: Trends in Horticultural Science	Paper Code: PHD-104/AG(III)	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	**Internal = 30**	**External = 70**

Course Objectives

1. To acquire knowledge of key challenges in fruit production and explore scientifically sound solutions.
2. To understand major problems affecting vegetable cultivation and examine appropriate remedial measures.
3. To analyze and evaluate recurring issues in horticultural crops, particularly fruits, and apply problem-solving strategies for sustainable production.

Unit	Contents	Lectures
I	Senile and seedling orchards- Replant problems and top working, insitu rain water harvesting and enhancing water use efficiency, Nutrient and irrigation scheduling, Fruit crop based cropping systems, pesticide residues and MRLs issues in fresh produce. GAPs in fruit production, HiTech banana & citrus production, Quality grape production in subtropical regions, crop regulation in pomegranate and guava, Quality plant material. Complex problems confronting fruit cultivation and their management: Alternate bearing in mango & apple, mango malformation, panama wilt of banana, citrus decline, guava wilt, coconut wilt, apple scab, chilling and pollination problems in temperate fruits, frost and virus problems in papaya and bacterial oil spot in pomegranate.	**15**
II	Damping off in vegetable nursery and its management, seed dormancy and its management, pollination issues in protected cultivation, fruit cracking and its management in fruit vegetables, drought mitigation under rain feed vegetable farming system, sprouting in potato and onion. Fruit borers in vegetable crops and elite strategies	**15**
III	Diamond black moth in cole crops, thrips in onion, thrips-mite complex in chilli, potato tuber moth, sweet potato weevil, root knot nematode and its management in vegetable crops Dieback and anthracnose in chilli, postharvest diseases management in bulbs-root-tuber vegetables, potato virus, YVMD in okra, onion purple blotch and bulb rot, CMV in cucurbits,	**15**
IV	Spices and Plantation crops: Pepper quick and slow wilt, spike shedding in pepper, kattae disease of cardamom, rhizome wilt and borer in turmeric, ginger, cardamom, rubberization in garlic, top working in nutmeg, coffee rust, tea mosquito bug in tea and cashew, mite complex in tea, root and stem borer in cashew, rhinoceros betel and red palm weevil in coconut, thanjavur wilt and stem bleeding in coconut, yellowing disorder in arecanut, yellowing disorder in jasmine, wilt/nematode	**15**

	complex in medicinal coleus, Climate change and horticulture production.	
	Total	**60**

Suggested Readings

1. Chadha, K. L. Handbook of Horticulture. 2nd ed., Indian Council of Agricultural Research (ICAR), 2019.
2. Bose, T. K., et al. Fruits: Tropical and Subtropical. Naya Udyog, 2001.
3. Peter, K. V., editor. Basics of Horticulture. New India Publishing Agency, 2016.
4. Ghosh, S. P., and H. P. Singh, editors. Trends in Horticultural Research. ICAR, 2001.
5. Pradeepkumar, T., et al. Horticulture: Principles and Practices. Oxford & IBH Publishing, 2016.
6. Dhaliwal, M. S. Handbook of Vegetable Crops. 3rd ed., Kalyani Publishers, 2017.
7. Singh, H. P., and S. K. Jain, editors. Advances in Horticultural Science. Westville Publishing House, 2015.
8. Kumar, N., et al. Introduction to Horticulture. Rajalakshmi Publications, 2004.
9. Chattopadhyay, T. K. A Textbook on Pomology (Vol. 1–3). Kalyani Publishers, 2005–2008.
10. Sharma, J. R. Statistical and Biometrical Techniques in Plant Breeding. New Age International, 2006.

Glocal School of Agricultural Science
Program: Ph.D.

Paper Name: Techniques in Plant Breeding	Paper Code: PHD-104/AG(IV)	Credits: 4 (4-0-0)
Evaluation (Maximum Marks = 100)	Internal = 30	External = 70

Course Objectives

1. Understand and apply fixed and random effect models in ANOVA, including expected variance components and MANOVA.
2. Analyze and interpret mean and variance comparisons using significance tests and biplot analysis.
3. Design plant breeding experiments and evaluate genetic diversity using metroglyph, cluster, and D^2 analyses.
4. Apply multivariate techniques such as path analysis, correlation, regression, PCA, and discriminant function analysis.

Unit	Contents	Lectures
I	Mendelian traits vs polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic andenvironmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.	15
II	Principles of Anaylis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance. Designs for plant breeding experiments - principles and applications; Genetic diversity analysis - metroglyph, cluster and D2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses.	15
III	Selection indices - selection of parents; Simultaneous selection models-concepts of selection - heritability and genetic advance. Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC.	10
IV	Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis-principles and interpretation.	10
V	QTL mapping, Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.	10

	Total	**60**

Suggested Readings

1. Allard, R. W. Principles of Plant Breeding. 2nd ed., Wiley, 1999.
2. Singh, B. D. Plant Breeding: Principles and Methods. 11th ed., Kalyani Publishers, 2021.
3. Acquaah, George. Principles of Plant Genetics and Breeding. 2nd ed., Wiley-Blackwell, 2012.
4. Sleper, David A., and John M. Poehlman. Breeding Field Crops. 5th ed., Wiley-Blackwell, 2006.
5. Sharma, J. R. Statistical and Biometrical Techniques in Plant Breeding. New Age International, 2006.
6. Plant Breeding." *FAO E-learning Academy*, Food and Agriculture Organization of the United Nations, https://elearning.fao.org/course/view.php?id=799
7. Basics of Plant Breeding." *ePG Pathshala*, Ministry of Education, Govt. of India, https://epgp.inflibnet.ac.in/
8. Plant Breeding and Genetics." *Iowa State University Extension and Outreach*, https://www.extension.iastate.edu/ag/plants
9. Plant Breeding and Genomics." *eXtension Foundation*, https://plant-breeding-genomics.extension.org/