

DEPARTMENT OF AGRICULTURAL STATISTICS
PALLI SIKSHA BHAVANA
VISVA-BHARATI, SRINIKETAN

Courses for Ph. D.

Course No.	Course Code	Course Title	Credits	Remarks
Course-1	STAT-601	Research methodology and techniques	4+0	Compulsory Course
Course-2	STAT-602	Advanced Statistical Methods	4+0	Compulsory Course
Course-3	STAT-603	Reviewing of published research work and presentation of synopsis	0+4	Compulsory Course
Course-4	RPE	Research and publication ethics	2+0	Compulsory Course
Course-5	STAT-604	Advanced data analytics	2+2	Optional
Course-6	STAT-605	Advanced Design of Experiments	3+1	Optional
Course-7	STAT-606	Modelling Techniques for Forecasting	3+1	Optional
Course-8	STAT-607	Recent Advances in the Field of Specialization	1+0	Optional
Course-9	STAT-691	Doctoral seminar-I	0+1	Optional
Course-10	STAT-692	Doctoral seminar-II	0+1	Optional

I. Course Title	:	RESEARCH METHODOLOGY AND TECHNIQUES
II. Course Code	:	STAT 601
III. Credit Hours	:	4+0

Objective

The course has been designed to give ideas about research and its various steps. Data being the core of any research, this course will also give ideas on data classification and their collection, sampling techniques and concepts of parametric and nonparametric inferential procedures.

Unit I

Concept and meaning of research, Purpose of research, Characteristics of research, Criteria of good research, Types of research. Construction of theories, Steps in research, Selection of research problems, Formulation and testing of hypotheses. Research Design—types of research design, need for a research design.

Unit II

Sources and types of data- Different formal and informal methods of data collection- Construction of structured schedule and questionnaire-pilot study and pretesting.

Variables –Classification of different types of variables, deferent measurement scales.

Unit III

Details of sampling procedures, Probability sampling: simple random sampling, stratified sampling, cluster sampling, systematic sampling, multistage sampling, pps sampling; Non probability sampling, quota sampling, spatial sampling, Survey procedures, Sampling errors.

Unit IV

Introduction to testing of hypotheses, Simple and composite hypotheses, Parametric and Nonparametric approaches, Concepts of errors, levels of significance

Standard parametric (univariate and bivariate populations) tests related to independent and dependent populations. Some standard nonparametric test procedures and their applications.

Outcome

The course is expected to enhance the skills of doing research. The power of drawing valid conclusions from the analysis of research data will also be increased.

Suggested Readings

- Bhattacharya, D. and Roychowdhury, S. *Probability and Statistical Inference: Theory and Practice*. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
- Bhattacharya, D. and Roychowdhury, S. *Nonparametric Statistical Methods*. MEDITECH.
- Kothari CR. 1980. *Research Methodology: Research and Techniques*, New Delhi: New Age International Publishers.
- Kumar A. 2008. *Research Methodology: A Survey*. Alts, New Delhi.
- Singh, D. and Chaudhary, F.S. *Theory and Analysis of Sample Survey Designs*. New Age International (P) Limited

I. Course Title	:	ADVANCED STATISTICAL METHODS
II. Course Code	:	STAT 602
III. Credit Hours	:	3+1

Objective

This is an advanced course in Statistical Methods which aims at imparting knowledge on some advanced level statistical tools used in the area of research having theoretical orientation and practical applications.

Theory

Unit I

Correlation and Regression Analysis: Fitting linear and nonlinear regression with single independent variable. Multiple linear regression, Multiple and partial correlation coefficients, Hypothesis testing related to population correlation coefficients and regression coefficients.

Unit II

Lack of fit, Pure error. Test of normality, test of linearity, Testing homoscedasticity and normality of errors, Durbin-Watson test. Test of goodness of fit for the model evaluation and validation, Concept of multi-collinearity

Unit III

Box-Cox family of transformations. Use of dummy variables, Over fitting and under fitting of model, Concept of nonlinear regression and fitting of quadratic, exponential and power curves.

Unit IV

Estimation: point and interval estimations, properties of estimators, Cramer-Rao lower bound. Methods of estimation: method of least squares, method of moments, method of maximum likelihood, minimum chi-square.

Unit V

Response model of fertiliser data, Determination of optimum dose with single input variable. Profit Maximization with quadratic and Mitscherlich's equations.

VI. Practical

Problems related to the topics mentioned in the theory syllabus.

Outcome

It is expected that the students will learn different statistical techniques of some advanced level. This will help students to carry out their research with confidence and they will be able to draw valid conclusions through analysis of research data.

Suggested Readings

- Bhattacharya, D. and Roychowdhury, S. *Probability and Statistical Inference: Theory and Practice*. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
- Bhattacharya, D. and Roychowdhury, S. *Statistics: Theory and Practice*. 3rd Ed. U.N. DHUR and Sons Pvt. Ltd.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. *Fundamentals of Statistics*. Vol. I & II. The World Press Pvt. Ltd.
- Gupta, S.C. and Kapoor, V.K. *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons.
- Hogg, R.V. McKean, J.W. and Craig, A.T. *Introduction to Mathematical Statistics*. 8th Ed. Pearson.
- Rao C.R. 2009. *Linear Statistical Inference and its Applications*. 2nd Ed. John Wiley.
- Rohatgi, V.K. and Ehsan, S. *An Introduction to Probability Theory and Mathematical Statistics*. Wiley Eastern Private Ltd.
- Searle S.R, Casella G and McCulloch C.E. 1992. *Variance Components*. John Wiley.
- Searle S.R. 1971. *Linear Models*. John Wiley.

I. Course Title	:	Reviewing of published research work and presentation of synopsis
II. Course Code	:	STAT 603
III. Credit Hours	:	0+4

Objective

The course will basically provide training on how to write the review of the published work while writing a thesis and how to present the research findings.

Unit I

Meaning of Thesis–Some basic dimensions and formality of submission-Components of thesis and their importance.

Unit II

Presentation and writing of synopsis of a research investigation.

Unit III

Developing Seminar presentation.

Unit IV

Writing the introduction, reviewing of literature, developing theoretical orientation, framing conceptual model, organization of research methods, analysing data and writing the findings, writing summary and conclusions, writing implications and framing empirical model, citing of the references and appendices.

Outcome

It is expected that student will learn different aspect of writing a Ph. D. thesis. Enough skills will be developed in writing different components of a thesis like introduction, review of literature, research methods, references etc.

Suggested Readings

- APA (2019). Publication Manual of the American Psychological Association. 7th Edition
- MLA (2008). Mla Handbook for Writers of Research Papers, Affiliated East-West Press Pvt Ltd
- MLA Handbook. Modern Language Association of America; 9th edition
- The Chicago Manual of Style. 17th edition, The University of Chicago Press
- T. L. Kate (2018). A Manual for Writers of Research Papers, Theses, and Dissertations. The University of Chicago Press

I. Course Title	:	RESEARCH AND PUBLICATION ETHICS (RPE)
II. Course Code	:	STAT 604
III. Credit Hours	:	2+0

Objective

This Course has a focus on basics of philosophy of science, research and ethics, research integrity, publication ethics etc. Hands-on-training (practical) are designed to identify a research misconducts and predatory publications. Indexing and citation database, open access publication, research metrics (citations, h-index, Impact Factor etc.) and plagiarism tools will be introduced in this course.

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

Modules	Unit Title	Teaching hrs.
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publication	4
RPE 05	Publication Misconduct	4
RPE 06	Databases and Research Metrics	7
	Total	30

Theory

RPE 01: PHILOSOPHY AND ETHICS

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature judgements and reactions

RPE 02: SCIENTIFIC CONDUCT

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

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 behaviour 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 PUBLICATION

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 developed by SPPU
4. Journal finder/journal suggestion tools viz JANE, Elsevier Journal Finder, Springer Journal Suggester etc.

RPE 05: PUBLICATION MISCONDUCT

A. Group Discussions

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

B. Software tools

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

RPE 06: DATABASES AND RESEARCH METRICS

A. Databases

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

B. Research Metrics

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

Outcome

It is expected that the students will learn different aspects of writing any article or manuscript or a Ph. D. thesis by following ethics like research integrity, plagiarism, research conducts etc. Enough knowledge will be developed on indexing, citation, impact factor, h-index and how to use a plagiarism checking tools etc.

Suggested Readings

- Bird, A. (2006). *Philosophy of Science*. Routledge.
- MacIntyre, A. (1967). *A Short History of Ethics*. London.
- Chaddah, P. (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN 978-938-748-0865.
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition*. National Academic Press.
- Resnik, D. B. (2011). What is ethics in research & Why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
- Beall, J. (2012). Predatory publishers are corrupting open access. Nature volume 489, page179, <https://doi.org/10.1038/489179a>
- Indian National Science Academy (INSA). Ethics in Science Education, Research and Governance (2019). ISBN: 978-81-939482-1-7 https://www.insaindia.res.in/pdf/Ethics_Book.pdf

I. Course Title	:	ADVANCED DATA ANALYTICS
II. Course Code	:	STAT 605
III. Credit Hours	:	2+2

Objective

This course is meant to expose the students towards the usage of various statistical packages used for analysing data. It would provide the students a hands-on experience in the analysis of their research data.

Theory

Unit I

Introduction to various statistical packages, Test for normality, Testing of hypothesis using Z chi-square, t and F statistics, ANOVA and ANCOVA, Analysis of crossed and nested classified designs.

Unit II

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

Unit III

Discriminant function; Cluster Analysis; Factor analysis; Principal component analysis; Multivariate tests of linear hypotheses; Fitting of non-linear models, Structural Equation model.

Unit IV

Analysis of time series data; Neural networks; nonlinear and generalized linear regression problem; Markov Chain; Monte Carlo simulation; Approaches to handling missing data

VI. Practical

Problems related to the topics mentioned in the theory syllabus.

Outcome

It is expected that the students will achieve expertise in handling different statistical packages for solving various research issues with a significant knowledge in interpreting the outputs of the analysed data.

Suggested Readings

- Anderson C.W. and Loynes R.M. 1987. *The Teaching of Practical Statistics*. John Wiley.
- Atkinson A.C. 1985. *Plots Transformations and Regression*. Oxford University Press.
- Chambers J.M., Cleveland W.S., Kleiner B and Tukey P.A. 1983. *Graphical Methods for Data Analysis*. Wadsworth, Belmont, California.
- Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall. Chatfield C. 1995. *Problem Solving: A Statistician's Guide*. Chapman & Hall.
- Velleman PF and Hoaglin DC. 1981. *Application, Basics and Computing of Exploratory Data Analysis*. Duxbury Press.
- Wetherill GB. 1986. *Regression Analysis with Applications*. Chapman & Hall.
- <http://freeststatistics.altervista.org/en/learning.php>.
- <http://freeststatistics.altervista.org/en/stat.php>.
- http://www.cas.lancs.ac.uk/glossary_v1.1/main.html.
- <http://www.stat.sc.edu/~grego/courses/stat706/>.
- www.drs.icar.gov.in.

I. Course Title	:	ADVANCED DESIGN OF EXPERIMENTS
II. Course Code	:	STAT 606
III. Credit Hours	:	3+1

Objective

This is an advanced course in Design of Experiments that aims at describing some advanced level topics for students who wish to pursue research in Design of Experiments. This course prepares students for undertaking research in this area. This also helps prepare students for applications of this important subject to agricultural sciences.

Theory

Unit I

Uniformity trials, size and shape of plots and blocks, Orthogonality, Contrasts, Analysis of variance, Analysis of covariance, Transformations of data.

Unit II

Completely randomized design, Randomized block design and Latin square design, Factorial experiments, Concept of confounding. Factorial experiments with extra treatment(s), Split plot and strip plot designs, Combined analysis.

Unit III

Balanced Incomplete Block (BIB) designs – general properties and construction of BIB designs, Partially balanced incomplete block designs with two associate classes - properties, and construction, Lattice designs, alpha designs, cyclic designs, augmented designs.

Unit IV

Response surface designs, Fractional factorial design, Cross-over designs, Groups of experiments, Sampling in field experiments.

VI. Practical

Problems related to the topics mentioned in the theory syllabus.

Outcome

The students would be exposed to various concepts of designing experiments so as to enable them understand the advanced level topics who wish to pursue research in Design of Experiments.

Suggested Readings

- Cochran, W.G. and Cox, D.R. 1957. *Experimental Designs*. 2nd Ed. John Wiley & Sons.
- Das, M.N. and Giri, N.C.: *Design and Analysis of Experiments*. Wiley Eastern Ltd.
- Dean, A.M. and Voss, D. 1999. *Design and Analysis of Experiments*. Springer.
- Fisher, R.A. 1953. *Design and Analysis of Experiments*. Oliver and Boyd.
- Gomez, K.A. and Gomez, A.A. *Statistical Procedures for Agricultural Research*. 2nd Ed. John Wiley & Sons.
- Gupta, S.C. and Kapoor, V.K. *Fundamentals of Applied Statistics*. Sultan Chand and Sons.
- Hinkelmann, K. and Kempthorne, O.: *Design and Analysis of Experiments*. Vol. I. John Wiley & Sons.
- Nigam AK and Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments*. IASRI
- Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theory and Practice*. John Wiley.
- www.drs.icar.gov.in.

I. Course Title	:	MODELING TECHNIQUES FOR FORECASTING
II. Course Code	:	STAT 607
III. Credit Hours	:	3+1

Objective

This course will prepare students in understanding the dynamics of the research data and provide knowledge in modelling such data. The course also aims to provide expertise in different forecasting techniques using suitable empirical and mechanistic models.

Theory

Unit I

Empirical and mechanistic models. Nonlinear growth models: monomolecular, logistic, Gompertz, Richards. First and second order input-output systems, Dynamics of a multivariable system.

Unit II

Forecast based on time series data: exponential smoothing, Box – Jenkins approach and non-linear models. Forecast models using weather parameters, crop-weather relationships and their use in yield forecast. Forecast using plant characters. Forewarning of crop pests and diseases.

Unit III

Multivariate time series, Modelling the mean, VAR model, STAR model, Estimation, analysis and forecasting, Structural time-series modelling: State space models, Kalman filter.

Unit IV

Markov chain: transition probability matrix of a Markov chain, Application of remote sensing techniques in forecasting, Artificial Neural Network (ANN) methodology Support vector machines, Wavelets for time series analysis.

VI. Practical

Problems related to the topics mentioned in the theory syllabus.

Outcome

It is expected that the students will be equipped with some advanced techniques of modelling different research data. They will develop expertise in forecasting techniques under different model conditions.

Suggested Readings

- Box G.E.P., Jenkins G.M. and Reinsel G.C. 2015. *Time Series Analysis: Forecasting and Control*. 5th Ed. John Wiley.
- Brockwell P.J. and Davis R.A. 1991. *Time Series: Theory and Methods*. 2nd Ed. Springer.
- Chatfield C. 2004. *The Analysis of Time Series: An Introduction*. 6th Ed. Chapman& Hall/CRC.
- Johnston J. 1984. *Econometric Methods*. McGraw Hill.
- Singh, P. 2016. *Applications of Soft Computing in Time Series Forecasting: Simulation and Modeling Techniques*. Springer International Publishing AG
- Tong H. 1995. *Nonlinear Time Series: A Dynamical System Approach*. Oxford Univ. Press.
- Vapnik, V. N. (2000). *The Nature of Statistical Learning Theory*. Springer- Verlag, New York.
- Percival, D.B. and Walden, A.T. 2000. *Wavelet Methods for Time-Series Analysis*. Cambridge University Press, U.K.

I. Course Title : **RECENT ADVANCES IN THE FIELD OF SPECIALIZATION**
II. Course Code : **STAT 608**
III. Credit Hours : **1+0**

Objective

To familiarize the students with the recent advances in the areas of their specialization and to prepare them for undertaking research.

Unit I

Recent advances in the field of specialization - sample surveys / design of experiments / statistical genetics / statistical modeling / econometrics / statistical inference, etc. will be covered by various speakers from the University / Institute as well as from outside the University / Institute in the form of seminar talks.

Outcome

It is expected that the students will get enough exposure about the research progress in their field of research. This course will help them in identifying doable research problems in their field of specialization.

Suggested Readings

Recent books, journals, research papers, thesis etc. related to the research works.