Department
of
Mathematics and Statistics

School of Mathematical and Physical Science

Curriculum Framework
Ph.D. Course Work Statistics

Session 2022-23 onward

Date of BoS -16/09/2022

Doctor Harisingh Gour Vishwavidyalaya
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Sagar-Madhya Pradesh-470003

Introduction

Mathematics and Statistics are the backbone of all sciences. Along with many other branches Statistics concerns with theory of estimation, Inference, Experimental design, Sampling, Data processing quantity control, Reliability, Mathematical finance, which are frequently used in all Physical sciences, Computer sciences and in Industry.

Students possessing Ph. D degree in Statistics have a very large numbers of job opportunities in the fields of banking, teaching, software development, Actuaries, Defense and jobs like Operations research analyst, Computer system analyst and Data analyst are the opportunities . The course is so designed that the students can also take employment as statistician country wide.

1. Name of the Programme: Ph. D. in Statistics.

2. Duration of Programme: The duration of programme (Ph.D. coursework) is one semester spread over a period of not less than 90 working days for a semester. The minimum duration, rules and regulation for completion of Ph.D. degree shall be as per the university ordinance.

3. Structure of Programme: The Ph. D. in Statistics programme includes one semester course work consisting of the Elective and Core courses with objectives and learning outcomes. Each course is divided into credits and number of teaching hours. Students having M.A./M.Sc. in Mathematics will be awarded Ph.D. in Mathematics and the students having M.A./M.Sc. in Statistics will be awarded Ph.D. in Statistics.

Total Credits of Coursework: 18

(i) Core courses : 10 credits

(ii) Elective course : 04 credits

(iii) Review of published work: 04 credits

4. Scheme of assessment of a course :

(i) Mid Sem Exam : 20 Marks

(ii) Internal Assessment : 20 Marks

(iii) End Semester Exam : 60 Marks

Total : 100 Marks

5. Medium of the instructions: English

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Summary of Ph. D. Course Work in Statistics

From Session 2022 -23 onwards

Semester-I

Paper Code	Title of Paper	Credit
RPE-CC-140	Research & Publications Ethics	2
STAT-CC-141	Research Methodology with Computer Applications	4
STAT-CC-142	History of Statistics and Modeling	4
STAT-CC-143	Review of Published Research Work	4
Opt any one from the following		
STAT-EC-1401	Mathematical Finance	4
STAT-EC-1402	Advanced Sampling & Modeling of Computer System	4
STAT-EC-1403	Theory of Estimation and Testing	4
STAT- EC-1404	Inventory Modeling and Optimization	4

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Ph. D. Course Work -I Semester

RPE-CC -140	Research & Publications Ethics	L	T	P	C
		2	0	0	2
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To inculcate the basic features of Philosophy.
(2) To acquainted with plagiarism (FFP).
(3) To introduce misrepresentation of data.
(4) To teach ethical & unethical behavior.

Unit–I: **(12 hours)**
Introduction to philosophy: definition, nature and scope, branches Ethics: definition, moral philosophy, nature of moral judgments and reactions.

Unit–II: **(12 hours)**
Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)

Unit–III: **(12 hours)**
Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Publication ethics: definition, introduction and importance.

Unit–IV: **(12 hours)**
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.

Unit–V: **(12 hours)**
Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.

Learning Outcomes: After completion of this course, the student will be able to learn the ethics & Intellectual honesty .

Books Recommended:

1. Bird, A (2006). Philosophy of Science. Routledge.
2. Macintyre, Alasdair (1967) A Short History of Ethics: London.
3. P. Chaddah, (2018) Ethics in Cometitive Research: Do not get scooped; do not get plagiarized, ISBN: 978-387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Gude to Responsible Conduct in Research: Third Edition. National Academies Press.
5. Resnik, D.B. (2011) What is ethics in research & why is t/it important National Institute of Environmental.
6. Health Sciences 1-10 Retrieved from http://www.nih.gov/research/resources/bioethics/whatis/index.cfm
7. https://doi.org/101038/489179a
8. Indian national Science Academy (INSA), ethics in Science Education, Research and Governance (2019), ISBN:978-81939482-1-7. http://www.insaindia.res.in/pdf/EthicsBookpdf

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Ph. D. Course Work -I Semester

STAT-CC -141	Research Methodology with Computer Applications	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To understand the concept of research.
(2) To learn about methodology and data collection and implementation.
(3) To learn about MATLAB.
(4) To find out the appropriate tool box of MATLAB to solve a specific problem.
(5) To learn about Mathematical writing using Latex.

Unit–I: **(12 hours)**
Objectives and Motivation of research. Types of research: descriptive vs. analytical, Applied vs. fundamental, Quantitative vs qualitative, Conceptual vs empirical. Research formulation. Research design and methods.

Unit–II: **(12 hours)**
Data collection and analysis. Observation and Collection of data. Method of data collections. Sampling method. Scientific report and thesis writing. Application of results and ethics, Copy right-royalty, intellectual property rights and patent law. Plagiarism, citations and acknowledgement.

Unit–III: **(12 hours)**
Statistical and Mathematical and Software: MATLAB – Introduction to MATLAB. MATLAB basics. Branching statements and loops.

Unit–IV: **(12 hours)**
User-defined functions, Solving differential equations in MATLAB, SPSS (Statistical Software). Basics of MATHEMATICA.

Unit–V: **(12 hours)**
Latex - Text and Maths, words, sentences, paragraphs. Command and environment. Document structure. Article class. Comments and footnotes. Change font characters. List environment. Style and size environment. Bibliography using Latex, Research paper writing. Thesis writing. Presentation using beamer class.

Learning Outcomes: After completion of this course the students will be able to understand the concept of Research. They will be able to write the synopsis report and can apply the software in own research works.

Essential Readings:

9. George Gratzer, More Maths into Latex, 4th edition, Springer, 2007.
10. Brian R. et al., A guide to Matlab for beginners and experienced users, CUP, 2001.

Suggested Readings:

1. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Pub., 1990.
2. B.L. Wadehra, Law relating to patents, trademarks, copy right, designs and geographical indications, Universal law publishing, 2000.
3. Stephen J. Chapman, Matlab programming for engineers, 2003.
4. Leslie Lamport, Latex: A document preparation system, Addison Wesley Publishing Comp., 1994.

E-book links: National Digital Library

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Ph. D. Course Work -I Semester

STAT-CC-142	History of Statistics and Modeling	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To introduce the origin of Mathematics and Statistics.
(2) To teach modeling of Phenomenon.
(3) To acquainted with application of Mathematics and Statistics.
(4) To introduce Numerical techniques.
(5) To provide the knowledge of item inventory and optimization.

Unit–I: **(12 hours)**
History of Mathematics and Statistics : Origins and counting in Mathematics, Babylon; 1700 to 300 B.C. Contributions of Indian Statisticians and Mathematician.

Unit - II: **(12 hours)**
Development of Vedic mathematics, Jaina tradition and astronomy tradition.

Unit - III: **(12 hours)**
Application Mathematical modeling, need, techniques. Classifications. Mathematical modeling through different equations.

Unit - IV: **(12 hours)**
Mathematical modeling through mathematical programming. Application of Statistical tools : calculus in daily life, different equations, Rocket launch trajectory analysis.

Unit - V: **(12 hours)**
Numerical analysis: curve fitting, Interpolation etc. Operations Research and optimization. Inventory control for factory parts, different inventory models, reliability and uncertainty of large scale physical simulations.

Learning Outcomes : After completion of this course the students will be able to understand the origin of Mathematics and Statistics, Mathematical modeling, application of Mathematical and Statistical tools, concepts of numerical analysis, techniques of curve fitting, forecasting through interpolation and optimization in Operations Research.

Essential Readings:

1. B.O.' Neill, Semi-Riemannan Geometry with application to Reliability, Academic Press,1983.
2. Oscar, E. Fernandez: Everyday Calculus: Discovering the Hidden Math All around Us, Printsasia, University Press, 2014.

Suggested Readings

1. Jacqueline Stedall: The History of Mathematics: A Very Short Introduction, Printsasia, New York.
2. B.B. Datta and A.N. Singh: History of Hindu Mathematics, A Source Book, (2 volumes), Motilal Banarasidas, 1935 (Part I) and 1938 (Part II), Asia Publishing House, Bombay, 1962 (reprint), Bharatiya Kala Prakashan.
3. B. N. Mandal, A. Chakrabarti: Applied Singular Integral Equation. CRC, 2011.
4. J. N. Kapoor: Mathematical modeling: New Age International Publishers, New Delhi.

E-book links: National Digital Library

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Ph. D. Course Work -I Semester

STAT-EC-1401	Mathematical Finance	L	T	P	C
		4	0	0	4
		Max. Marks: 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To study Probability and its properties.
(2) To understand Brownian motion.
(3) To explain interest rate & its properties.
(4) To study Stochastic integration and Stochastic differential equations.
(5) To understand the Black Scholes formula and its properties.

Unit – I: **(12 hours)**
Probability, Real valued random variables, Conditional probability. Expectation, Normal Random Variable & its properties.

Unit – II: **(12 hours)**
Brownian motion & Geometric Brownian motion. The Cameron martin Theorem.

Unit – III: **(12 hours)**
Interest rate & present value analysis. Rate of Return, Continuously varying interest Rates. Pricing contracts via arbitrage. The Arbitrage theorem.

Unit – IV: **(12 hours)**
Stochastic integration, Stochastic differential equations. The stock price as a stochastic process, option pricing, contracts, derivatives, options & futures.

Unit – V: **(12 hours)**
The Black Scholes formula, Properties of the Black-Scholes option costs. The Delta Hedging Arbitrage strategy. European put option.

Learning Outcomes: After completion of this course the students will understand the procedure of option pricing based on the Black Scholes formula.

Essential Readings:

1. **Franke, J., Hardle, W.K. And Hafner, C.M. (2011):** Statistics of Financial Markets: An Introduction, 3rdEdition, Springer Publications.

Suggested Readings

1. **Stanley L. S. (2012):** A Course on Statistics for Finance, Chapman and Hall/CRC.

E book links: National Digital Library

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Ph. D. Course Work -I Semester

STAT-EC-1402	Advanced Sampling & Modeling of Computer System	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To introduce estimator for mean and variance.

(2) To teach estimation in post- stratification.

(3) To acquainted with small area estimation.

(4) To introduce Markov chains.

(5) To teach mean estimation in lottery scheduling.

Unit-I: **(12 hours)**
Factor Type(F-T) estimator for mean and variance, Efficient F-T estimator , Transformation in F-T estimator, Two phase F-T estimator,

Unit-II: **(12 hours)**
Estimation in deep-stratification, Sources of non- response, Post-stratification, Mean estimation in post-stratification.

Unit III: **(12 hours)**
Small area estimation, Direct, Synthetic and other estimators, Graph theory, Some general and specific graphs, Properties of graphs, Directed and undirected graphs, Graph sampling using isomorphic, binary, spanning and planer graphs.

Unit-IV: **(12 hours)**
Markov chains, Applications of Markov chains and Markov processes, Birth and death processes, CPU scheduling

Unit-V: **(12 hours)**
Lottery scheduling, Ready-queue parameter estimation using lottery scheduling, Use of F-T estimator for mean estimation in lottery scheduling.

Learning Outcomes: After completion of this course the students will be able to understand the sampling and modeling of computer system.

Essential Readings:

1. **Medhi. J.:** Stochastic Process, New Age International Publishers, New Delhi.
2. **Deo, Narsingh:** Graph Theory, PHI Publication.
3. **Rao, J. N. K.:** Small Area Estimation, John Wiley, New York.

Suggested Readings:

1. **Mukhopadhyaya, P.:** Theory and Methods of Survey sampling, PHI, New Delhi.
2. **Shukla , D and Rajput, Y. S.:** Graph sampling , Aman Prakashan, Sagar.
3. **Silberschatz and Galvin :** Operating System, Addison Wesley.

E-book links: National Digital Library

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Ph. D. Course Work -I Semester

STAT- EC-1403	Theory of Estimation and Testing	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives: (1) To learn properties of estimator.

(2) To find best estimator criterion.

(3) To understand Baye's estimation criterion.

(4) To check advanced properties of estimation in order of admissibility.

(5) To study simulation in inference.

Unit-I: **(12 hours)** Elements of decision theory such as complete class theorem, Admissibility of Bayes rule, Minimax Theorem Review of sufficiency, Consistency and efficiency,
Unit-II: **(12 hours)** UMVU estimators and their properties, Application to normal and exponential one and two sample problems.
Unit-III: **(12 hours)** Information inequality (multiple parameter case) Equivariance, Invariance. Application to location and scale families. Bayes and minimax estimation for exponential families.
Unit-IV: **(12 hours)** Admissibility of estimators, Blyth's ratio method, Karlin's sufficient conditions.
Unit-V: **(12 hours)** Pitman's estimator and its properties, Simultaneous estimation. Stein's phenomenon, Shrinkage estimation.

Learning Outcomes: After completion of this course the students will be able to find out parametric value (mean, variance etc.) on the basis of random sample with minimum error. Also the students will be able to almost all research based on sample survey.

Essential Reading

1. **E. L. Lehmann:** Theory of Statistical Inference, Wiley, 1983.
2. **S. Zacks:** The Theory of Statistical Inference, Wiley, 1971.
3. **Jun Shao:** Mathematical Statistics, 2nd Ed., Springer, 2003.

Suggested Reading :

1. **J. Berger:** Statistical decision theory, Springer-Verlag, 1980.
2. **T. S. Ferguson:** Mathematical Statistics: A Decision Theoretic Approach, Academic Press, 1967.

E-book links: National Digital Library

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Ph. D. Course Work -I Semester

STAT- EC-1404	Inventory Modeling and Optimization	L	T	P	C
		4	0	0	4
		Max. Marks : 100			

Mid Sem-20
Internal assessment-20
End Sem-60

Objectives:

(1) To understand importance of inventory and production system
(2) To develop replenishment policy
(3) How to make production policy
(4) To develop probabilistic inventory model
(5) Formulation of setup cost model.

Unit – I: **(12 hours)**
Inventory & Production Management **:** Deterministic inventory models of uniform rate of demand and non- uniform rate of demand.
Unit – II: **(12 hours)**
Economic lot-size with finite rate of replenishment. Economic order quantity models with constant rate of demand. Production lot size model with shortage
Unit – III: **(12 hours)**
Buffer stock. Production planning and inventory control .
Unit – IV: **(12 hours)**
Probabilistic inventory models, Fixed order quantity model. .
Unit – V: **(12 hours)**
Probabilistic order–level system with constant lead time. Instantaneous demand no set-up cost model and Uniform demand no set-up cost model. .

Learning Outcomes: The course is building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints. After completion the course student be able to design new inventory models by incorporating new parameters. This course have been design for research purpose in this way the researcher may identify new inventory problems and formulae them to get optimal solution.

Essential Readings :

1. H. A. Taha: Operations Research- An Introduction, Macmillan publishing INC., New-York.
2. S. D. Sharma: Operations Research, Kedar Nath Ram Sons co.Publisher Meerut thirteenth - edition) 2001.
3. Kanti Swarup, P.K. Gupta & Man Mohan: Operations Research, Sultan Chand & sons, New Delhi.
4. Edward A. Silver, David F. Payke and Rein Peterson: Inventory Management and Production Planning and Schedeling, (third edition). John Wiley & Sons.
5. Khedlekar U K and Shukla, D, Advanced Inventory Models: Aman Prakashan Sagar MP.
6. S. C. Sharma: Operations Research inventory control and Queuing theory, Discovery publishing house Delhi.

Suggested Reading and Links

1. **Video lecture** on Inventory Management | Concepts, Examples and Solved Problems
   Link https://www.youtube.com/watch?v=2n9NLZTIlz8
2. Video lecture on Probabilistic Model (Inventory Model)
   Link https://www.youtube.com/watch?v=9qtgQK3BQTk

E book links: National Digital Library

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STAT- CC-143	**Review of Published Research Work**	**L**	**T**	**P**	**C**
		8	**0**	**0**	**8**
Concern Research Advisor/Supervisor		**Max. Marks : 100**			

Mid Sem-20
Internal assessment-20
End Sem-60