Syllabus for One-Year Postgraduate Programme in Statistics

Curriculum and Credit Framework (CCF) for Postgraduate Programmes
(Following NEP 2020)
With Effect from the Academic Session 2026-2027

Department of Statistics
Siksha Bhavana (Institute of Science)
Visva-Bharati (A Central University)
Santiniketan – 731235, West Bengal, India

One-Year Postgraduate Programme in Statistics	Courses	Credits	Total Credits	Total Marks for One-Year Postgraduate Programme in Statistics
Semester-I	STATPG01 Real Analysis and Measure Theory	4	20	500
	STATPG02: Time Series Analysis	4		
	STATPG03: Introductory Data Science and Machine Learning	4		
	STATPG04(1): Elective Paper : Advanced Sample Survey	4		
	OR			
	Elective Paper: STATPG04(2): Econometrics	4		
	STATPG05: Practical based on the topics covered in STATPG02, STATPG03 and STATPG04(1) OR STATPG04(2)	4		
Semester-II	STATPG06: Reliability Analysis	4	20	500
	STATPG07(1): Elective Paper: Advanced Design of Experiments	4		
	OR			
	STATPG07(2): Elective Paper: Clinical Trials and Bioassay	4		
	STATPG08: Practical based on the topics covered in STATPG06 and STATPG07(1) OR STATPG07(2)	4		
	STATPG09: Dissertation	8		
Total 2 Semesters (One Year)	Total Courses: 9 (For 1 Year Course)	Total Credits: 40 (For 1 Year Course)		Total Marks: 1000 (For 1 Year Course)

Detailed Course Structure

1 credit = 1 hour theory class / 2 hours practical or dissertation per week in a semester, and 1 Credit = 25 mark

* Students will opt for one 'MOOCS/SWAYAM' course (NcRF level 6; 4 credits theory only; as per university rules);
alternatively, they can opt for Optional Courses which will be offered to students from other departments of Visva-Bharati. Students undergoing an MSc in Statistics will have to take these courses offered by other departments of Visva-Bharati.

Outline of the Learning Outcome-based Curriculum Framework Syllabus for One-Year Postgraduate Programme in Statistics following NEP 2020

Course Code	**Course Type**	**Course title with NCrF Level**	**Credits**	**Marks**	**Class Hrs /week**
SEMESTER-I (One-Year PG)					
STATPG01	Theory	Real Analysis and Measure Theory (NCrF level 6.5)	4	100	5
STATPG02	*Theory*	Time Series Analysis (NCrF level 6.5)	4	100	5
STATPG03	Theory	Introductory Data Science and Machine Learning (NCrF level 6.5)	4	100	5
STATPG04(1)	*Theory*	Advanced Sample Survey (NCrF level 6.5)	4	100	5
STATPG04(2)	Theory	Econometrics (NCrF level 6.5)	4	100	5
STATPG05	*Practical*	Practical based on the topics covered in STATPG02, STATPG03 and STATPG04(1) OR STATPG04(2) (NCrF level 6.5)	4	100	6
		Total	**20 Credits**	**500**	
SEMESTER-II (One-Year PG)					
STATPG06	*Theory*	Reliability Analysis (NCrF level 6.5)	4	100	5
STATPG07(1)	*Theory*	Advanced Design of Experiments (NCrF level 6.5)	4	100	5
STATPG07(2)	Theory	Clinical Trials and Bioassays (NCrF level 6.5)	4	100	5
STATPG08	*Practical*	Practical based on the topics covered in STATPG06 and STATPG07(1) OR STATPG07(2)	4	100	4
STATPG09	*Project*	Dissertation (NCrF level 6.5)	8	200	4
		Total	**20 Credits**	**500**	
TOTAL: 9 COURSES (For One-Year PG Course)			**40 Credits**	**1000**	

Examination pattern

Examination Pattern	Internal Assessment: 20% of the full marks (except) For the dissertation papers (), it will be based on periodic assessment, preferably conducted at least twice in a semester
	End-of-Semester Examination: 80% of the full marks (100% of the full marks for)
	Evaluation of the review () and dissertation papers () papers will be done based on the report submission, presentation, and interaction
Duration of Examination	Theory (80 marks or above): 4 hours
	Theory (up to 60 marks): 3 hours
	Practical (up to 20 marks): 2 hours
	Practical (above 20 marks): 4 hours;
Tentative Question Pattern	**Theory (60 marks):** 5 questions of 2 marks each (out of 8 questions): 2x5=10; 6 questions of 5 marks each (out of 9 questions): 6x5=30; 2 questions of 10 marks each (out of 3 questions): 10x2=20. **Theory (80 marks):** 5 questions of 2 marks each (out of 8 questions): 2x5=10; 8 questions of 5 marks each (out of 12 questions): 5x8=40; 3 questions of 10 marks each (out of 5 questions): 10x3=30.

Semester I

STATPG01 (Real Analysis and Measure Theory) (Credit 4)

Course Objective: *The course is spitted into two parts: Real analysis and Measure theory. The objective of this course is to provide some basic and advanced ideas of real analysis and measure theory. The real analysis part mainly develops the student's analytical thinking and some prerequisite ideas of measure theory. The measure theory part helps the student to gain the knowledge about various measures. This part also develops the concept of probability and its related terms from the view of measure theory.*

Learning Outcomes: *After completing the course the students will be able to: ·*

1. *Understand various advanced ideas of real analysis like compact sets, Heine– Borel theorem etc.*
2. *Understand sequence, series of functions and their convergence.*
3. *Analyze the power series and related terms about its convergence.*
4. *Know the terms related to different measures and their importance.*
5. *Study the concept of random variables and its convergence.*
6. *Grasp the idea of characteristic functions, law of large numbers and central limit theorem.*

Real Analysis: Introduction to real numbers, Introduction to n-dimensional Euclidian space, open and closed intervals (rectangles), compact sets, Bolzano-Weirstrass theorem, Heine–Borel theorem. (8L)

Real valued functions, continuous functions, uniform continuity, sequences of functions, uniform convergence; Power series and radius of convergence. (7L)

Measure Theory: Classes of sets, fields, sigma-fields, Borel sigma-field in Rk, sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue Steljes measures on Rk. (10L)

Measurable functions, Random variables, sequence of random variables, almost sure convergence, convergence in probability and convergence in distribution. Monotone convergence theorem (Statement only). Fatou's lemma (Statement only), Dominated convergence theorem (Statement only). (10L)

Borel-Cantelli Lemma (Statement only), Weak law and strong law of large numbers for iid sequences.CLT for a sequence of independent random variables under Lindeberg's condition, CLT for iid random variables. (10L)

Characteristic function, Levy's continuity theorem (statement only) (5L)

SUGGESTED READINGS:

1. Cramer, H. (1946): Mathematical Methods of Statistics, Princeton.
2. Pitman, J. (1993): Probability, Narosa publishing House. Ash, R. (1972): Real analysis and probability, Academic Press.
3. Billingsley, P. (1986): Probability and Measure, Wiley.
4. Dubley, R. M. (1989): Real Analysis and Probability, Wordsworth and Brooks/Cole.
5. Kingman, J. F. C. and Taylor, S. J. (1966); Introduction to Measure and Probability.

STATPG02 (Time Series Analysis) (Credit 4)

Course Objective: *To impart the concept of time series and how to develop statistical models to forecast a time series for practical use/planning.*

Learning Outcome: *After completion of the course, students should be able to*

1. *Distinguish time series and cross-sectional data.*
2. *Model various real-life time series data and forecast them along with the forecast errors.*

Smoothing Time series using filters.(4L)

Representation of time series as a stochastic process. Weakly and strongly Stationary process and their examples. (8L)

Ergodicity, sufficient condition for ergodicity. (4L)

Autocorrelation and partial autocorrelation functions and their properties (6L)

AR, MA, ARMA models and their properties. Estimation of ARIMA model parameters, Forecasting: minimum MSE forecast using ARIMA models (12L)

ARCH, GARCH and ARIMAX (6L)

Spectral Analysis of weakly Stationary process. Periodogram and correlogram analysis. (10L)

SUGGESTED READINGS:

1. Anderson, T.W.: The Statistical Analysis of Time series
2. Brockwell and Davis (2002): Introduction to Time series and forecasting
3. Gujarati, D.: Basic Econometrics

STATPG03 (Introductory Data Science and Machine Learning) (Credit 4)

Course Objectives: *The aim of this module is to apply quantitative modeling and data analysis techniques to the solution of real world business problems, communicate findings and effectively present results using data presentation and visualization techniques.*

Learning Outcomes: *After finishing this course the students should be able to*

1. *recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.*
2. *apply ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions.*
3. *demonstrate knowledge of statistical data analysis techniques utilized in business decision making.*
4. *apply principles of Data Science to the analysis of business problems. use data mining software to solve real-world problems.*
5. *apply algorithms to build machine intelligence.*

Definitions, Data wrangling, Descriptive Analytics and visualization (8L)

Feature extraction techniques (6L)

Supervised learning: Regression and Classification (10L)

Unsupervised learning (6L)

Ensemble learning (averaging, Decision tree, Logistic regression, Support Vector Machines, Bagging, Random Forest, Boosting and gradient boosting), association rules, text mining. (20L)

All the above techniques should be demonstrated using either of R or Python or both.

SUGGESTED READNIGS:

1. An Introduction to Statistical Learning- with Applications in R: Gareth James , Daniela Witten , Trevor Hastie , Springer, 2013.
2. The Elements of Statistical Learning- Data mining, Inference and Prediction: Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2003
3. Machine Learning for Hackers: Drew Conway and John Myles White, O'Reilly, 2012.

STATPG04(1) (Advanced Sample Survey) (Credit 4)

Course Objective: *Sample Survey After the introduction of the sampling schemes like Simple random Sampling, Stratified Random Sampling and Systematic Sampling in UG, this course consists of the details of the some advanced sampling schemes like Cluster Sampling, Two-stage sampling, Double Sampling, PPS sampling etc. The randomized response techniques for the surveys regarding sensitive topics are also introduced. The objective of the course is to prepare the students for all real life survey situations.*

Learning Outcomes: *After completion of the course, the students will be able to*

1. *Conduct a randomized response based survey regarding some sensitive characteristic.*
2. *Estimate the proportion of individuals having some sensitive characteristic.*
3. *Understand some basics of survey design.*

4. *Estimate the population mean/total as well as the variance of the estimators under different sampling schemes, viz Cluster Sampling, Two-stage Sampling, Double Sampling and PPS Sampling.*

Two-stage and Double Sampling and related results in estimation of population mean and total. Allocation problem in two-stage and double sampling. (15L)

Concepts of Sampling Design and Design based Inference. Rao-Blackwellization of estimators. (10L)

Unequal probability sampling: ppswr/wor methods [including Lahiri's Scheme] and related estimators of a finite population [Hansen-Hurvitz and Desraj Estimators for a general sample size and Murthy's Estimator for a sample of size 2]. Rao-Hartley and Cochran's sampling strategy and Midzuno's sampling strategy. (15L)

Randomized Response Technique. (10L)

SUGGESTED READINGS:

1. Chaudhuri, A. and Vos, J. W. E. (1988): Unified Theory and Strategies of Survey Sampling, North Holland, Amsterdam.
2. Chaudhuri, A. and Mukerjee, R. (1988): Randomized Response– Theory and Techniques, New York, Marcel Dekker Inc.
3. Cochran, W. G. (1984): Sampling Techniques, 3rd Ed. Willey.
4. Des Raj and Chandhok (1998): Sampling Theory, Narosa.
5. Mukhopadhyay, P. (1998): Small area estimation in survey sampling, Narosa

OR

STATPG04(2) (Econometrics) (Credit 4)

Course Objectives: *To impart the knowledge of problems with violation of different assumptions while modelling real-life economic problems to solve using statistical theories and how to find solutions to those.*

Learning Outcomes: *After finishing this paper the students should be able to identify the assumption(s) being violated in a real-life (economic) dataset and to remove the issue from it and model the data for practical use.*

Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, residual diagnostics, review of Gauss Markov model. (8L)

Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error. (10L)

Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation. Heteroscedastic disturbances:

Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutions of heteroscedasticity. (22L)

Autoregressive and Lag models, Dummy variables, Qualitative data for structural and reduced model, logit, probit model. (10L)

SUGGESTED READINGS:

1. Johnston, J. & Dinardo, J. (2005): Econometric Methods (4th Ed.); McGrow-Hill
2. Greene,W.H. (2020): Econometric Analysis; Pearson Education
3. Gujrati, D.N. (2025): Basic Econometrics; McGrow-Hill

STATPG05 (Practical based on topics covered in STATPG02, STATPG03 and STATPG04(1)/STATPG04(2)) (Credit 4)

Semester II

STATPG06 (Reliability Analysis) (Credit 4)

Course Objective: *To impart the concept of reliability and how statistical and probabilistic theories are applied to model and explain life of a mechanical component along with prediction of the same.*

Learning Outcomes: *After completing this course, students will be able to*

1. *model and explain the operation time of a mechanical component.*
2. *predict the reliability of a component, system and of a finished product.*
3. *explain the nature of the lifetime of an item as well. Reliability concepts and measures,*

Components & systems: coherent systems, reliability of the coherent systems. Cuts and paths, modular decomposition, bounds on system reliability; structural and reliability importance of components. (8L)

Life distributions, reliability function, hazard rate, common life distributions: exponential, Weibull, gamma etc. (6L)

Reliability estimation based on failure time in various censored life tests. Stress-strength reliability and its estimation. (7L)

Notions of ageing, IFR, IFRA, NBU, DMRL and NBUE and their duals, loss of memory property of the exponential distribution. Closures of these classes under formation of Coherent systems, Convolution and Mixtures. (9L)

Univariate shock models and life distribution arising out of them. Bivariate shock models, common bivariate exponential distribution and their properties. (6L)

Maintenance and replacement policies; availability of repairable systems; modeling of a repairable system by a non-homogeneous Poisson process. (8L)

Basic ideas of accelerated life testing and basic ideas of software reliability. (6L)

SUGGESTED READING:

1. Barlow R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life testing:
2. Holt, Rinehart and Winston. Lawless J.F. (1982): Statistical model and Methods of Life time data, John Willey.
3. Bain L.J. and Engelhardt (1991): Statistical Analysis of Reliability and Life testing Models, Marcel Dekker.
4. Nelson, W. (1982): Applied Life Data Analysis, John Willey.

STATPG07(1) (Advanced Design of Experiments) (Credit 4)

Course Objective: *The objective of the course is to develop a systematic method to determine the relationship between factors affecting a process and the output of the process. It is used to find out cause and effect relationship. This information is needed to manage process inputs in order to optimize the output.*

Learning Outcomes: After completion of the course, the students will be able to

1. *Analyze generalized block designs.*
2. *Analyze a block design with missing observations.*
3. *Understand the purpose of confounding and analyze a factorial design with some confounded effects.*
4. *Construct Balanced Incomplete Block designs by different methods.*

Factorial experiments: 2^n, 3^n factorial experiments, illustrations, main effects and interactions, confounding and illustrations. (10L)

Split and Strip plot Analysis. (5L)

General block design and its information matrix (C). (7L)

Criteria for connectedness, balance and orthogonality. (5L:)

Intra-block analysis including estimability, best point estimates, interval estimates of estimable linear parametric functions and testing of linear hypotheses. Combined inter-intra block analysis (8L)

BIBD: Description, construction and Analysis. (15L)

SUGGESTED READING:

1. Dey, Aloke (1986): Theory of Block Designs, Wiley Eastern.
2. Dean, A. and Voss, D. (1999): Design and Analysis of Experiments, Springer.
3. Das, M. N. and Giri, N. (1979): Design and Analysis of Experiments, Wiley Eastern.
4. Joshi, D. D. (1987): Linear Estimation and Design of Experiments, Wiley Eastern.
5. Montgomery, C. D. (1976): Design and Analysis of Experiments, Wiley, New York.
6. Searle, S. R., Casella, G. and McCulloch, C. E. (1992): Variance Components, Wiley

OR

STATPG07(2) (Clinical Trials and Bioassay) (Credit 4)

Course Objective: *Bioassays are essential tools for pre-clinical research. By revealing whether a compound or biologic has the desired effect on your biological target, bioassays can drive decision-making throughout the drug discovery process, to ultimately bring new drugs to patients. This course will specially help the students who are interested to get involved in clinical research.*

Learning Outcome: *After the completion of the course, the students should be able to:*

1. *Understand the concept of basic study designs, group sequential design and adaptive designs.*
2. *Understand the notion of clinical trials.*
3. *Understand different types of biological assays.*
4. *Get involved in medical research.*

Clinical Trials: Introduction, Basic Study Design, Randomization and Blinding Ethical Issues in Clinical Trials. Sample Size, Trial Conduct and Monitoring Group sequential designs and interim stopping rules. Adaptive Designs. Issues in Data Analysis, Closeout, Reporting and Interpreting of Results. (25L)

Bioassay: Logic of biological assay; dosage response curves; quantitative and quantal responses; parallel line and slope-ratio assays; simplified estimators; sequential assays; problem of design. PK/PD Models : Compartment models and their identifiability, Numerical solutions of coupled differential equations, Mixed effects models and population PK/PD (25L)

SUGGESTED READINGS:

1. Friedman LM, Furberg CD, DeMets DL. Fundamentals of Clinical Trials. 3rd ed. Mosby-Year Book, Inc., St. Louis, 1996.
2. S.Piantadosi: Clinical Trials- A Methodologic Perspective
3. B.S.Everitt and A.Pickles: Statistical Aspects of Design & Analysis of Clinical Trial
4. J.Whitehead: The Design and Analysis of Sequential Clinical Trials
5. Z.Govindarajulu: Statistical Techniques in Bioassay
6. D.J.Finney: Statistical Methods in Bioassay

STATPG08 (Practical based on topics covered in STATPG06 and STATPG07(1)/STATPG07(2)) (Credit 4)

STATPG09 (Dissertation) (Credit 8)

INDIAN KNOWLEDGE SYSTEM (IKS) INCLUSION

Course	IKS-related Portion	Connection with Indian Knowledge System	Learning Outcome
STATPG04(1) – Advanced Sample Survey	Rao–Blackwellization, Lahiri's PPS Sampling Scheme, Des Raj Estimator, Rao–Hartley–Cochran Sampling Strategy.	Contains methods developed by eminent Indian statisticians including C. R. Rao, D. B. Lahiri and Des Raj, representing major Indian contributions to sampling theory.	Students will be able to explain and implement sampling procedures developed by Indian statisticians and apply them in national surveys, official statistics and policy research.
STATPG07(1) – Advanced Design of Experiments	Balanced Incomplete Block Designs (BIBD), Block Designs.	Modern design theory includes significant contributions from R. C. Bose in combinatorial design theory.	Students will understand the theoretical basis of block designs, construct BIBDs, and appreciate India's contributions to combinatorial design theory.