**Department of Statistics**
**Central University of Rajasthan**


# SYLLABUS for Pre-Ph. D Course Work in STATISTICS

**Proposed to be implemented from July 2019**

**Department of Statistics**
**School of Mathematics Statistics and Computational Sciences**
**Central University of Rajasthan Bandarsindri, NH-8, Kishangarh, Ajmer, Rajasthan-305801**

**Effective from July-2019**

The Ph.D. Programme are the research programme in the respective subject, as such students have to be well acquainted with various research methodologies including current state of art of development in the concerned subject. In view of it Ph.D. programme offered by department of Statistics offers research methodology and recent trends in statistics as compulsory subjects.

**Objective:** The main objective of to make students aware of various methods of research in statistics and use them in their specific research topic.

**Learning Outcomes.:** Upon getting acquainted with the various research method and recent trends/development in the statistics, students will be well equipped to make substantial research contribution in the topic of their specialization.

Every student enrolled is required to register for at least three courses; PST 611 and PST 612 are compulsory, while the student can choose any one of the elective courses, PST 621-631 in consultation with the faculty member of the Department. A Ph D student is encouraged to register / audit Ph D level courses in other departments also . The total number of credits for each student shall be not less than 12.

| **Compulsory Papers** | | |
|---|---|---|
| Course Code | Course Title | Credits |
| STA 701 | Research Methodology | 4 |
| STA 702 | Recent Trends in Statistics | 4 |
| **Elective:** Student need to select one paper from the courses listed below as per his/her research interest | | |
| STA 703 | Reliability Theory and Survival Analysis | 4 |
| STA 704 | Stochastic Processes for Insurance and Finance | 4 |
| STA 705 | Advanced Time Series Analysis and Econometrics | 4 |
| STA 706 | Sampling Techniques | 4 |
| STA 707 | Statistical Quality Control | 4 |
| STA 708 | Frailty Models | 4 |
| STA 709 | Advance Bayesian Inference | 4 |
| STA 710 | Extreme Value Theory | 4 |
| STA 711 | Total Quality Management | 4 |
| STA 712 | Applied Demography | 4 |
| STA 713 | Advanced Computational Techniques | 4 |

## DETAILED SYLLABUS

### STA 701: Research Methodology Credit-4

**Objective:**
The objective of this paper is to introduce the basic knowledge about how to design the research problem and the fundamentals of research in concern discipline.

**Learning Outcomes:**

1. The students will understand the concept and importance of the research in any discipline. Also Identification and development of the research problem.
2. Acquire the knowledge about different method of data collection and related methodology of different sampling procedures.
3. The researcher will trained in subject related area to understand the current trend in research. Also, aware about the use of different tool and techniques via statistical computation.

**Unit 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

**Unit 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.

**Unit III**

Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. 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: Method of Data Collection and Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

**Unit IV**

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, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like R-software, SPSS, etc, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

**References:**


1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C. R. Kothari
4. Select references from the Internet.

**STA 702-Recent Trends in Statistics** **(Credit-4)**

**Objective:** This paper has been designed to learn about the current trend in probability theory and inferential statistics.

**Learning Outcomes:**

1. Students will learn about the fundamentals of probability theory and point estimation theory.
2. To explore and apply the statistical computation via MCMC technique.
3. Acquire the knowledge about application of stochastic process.

**Unit I**

Probability as a measure, probability space. Conditional probability. Random variables. Distribution function-continuous, discrete and mixed. Decomposition of a distribution function. Independence. Expectation. Moments. Characteristic function. Sequences of random variables. Dominated and monotone convergence theorems. Modes of stochastic convergence, laws of large numbers and central limit theorems.

**Unit II**

Review of estimation theory, point estimation, Testing of hypothesis and confidence intervals, Model fitting and prediction. Introduction to Bootstrap and Jackknife methods, Markov Chain Monte Carlo Methods and applications EM algorithm, Metropolis-Hasting Algorithm, Gibbs Sampling.

**Unit III**

Stochastic Processes: Markovian property, continuous time Markov Chains, Poisson Process, Birth and Death Process, Application in Insurance and Finance. Brownian Motion: Basic concepts of Stochastic Differential equations, Ito integrals, Geometric Brownian motion

**Unit IV**

Concept of simulation and Empirical study, Latest research paper reading and presentation. One research Principles of life and health Insurance: Types of Life insurances, Health insurance, Mortality and its role in Pricing, Solvency; Human development index, income, education, purchasing power.

**References:**


1. Efron, B and Tibshirani, R (1993) An Introduction to the Bootstrap, Chapman & Hill.
2. Lehmann E.L. and Romano J.P.(2005): Testing Statistical Hypotheses, Springer
3. Lehmann E.L. and Casella George.(1998): Theory of Point Estimation, Springer Inc.
4. Chernick, M. R. (2008), Bootstrap Methods: A Guide for Practioners and Researchers, John Wiley and Sons, New York.
5. Peter Hall (1997) The Bootstrap and Edgeworth Expansion, Spinger-Verlag, New York.
6. Karlin, S. and Taylor, H. M. (1975) A First Course in Stochastic Processes, Academic Press.
7. Karlin, S. and Taylor, H. M. (1981) A Second Course in Stochastic Processes, Academic Press.
8. Ross, S. (1996) Stochastic Processes, John Wiley and Sons, New York.
9. Lin Sheldon, Introductory Stochastic Analysis For Finance And Insurance, John Wiley and sons.
10. Ruppert David: Statistics and Finance: An Introduction, Springer.
11. Booth, P. M.; Chadburn, R. G.; , Modern actuarial theory and practice, CRC Press.

**STA 703-Stochastic Processes for Insurance and Finance** **Credit-4**

**Objective:** The main objective of this course is to introduce concepts of Stochastic processes in Insurance and Finance.

**Learning Outcome:** The student will learn

- Stochastic modeling of Claim count and Claim size process
- Modelling of Risk (individual and collective risk models)
- Determination of Ruin Probability and Modelling of Renewal Process

**Unit I**

Concept of Insurance and Finance: Claim Number Process, Claim Size Process, Premium, Risk Reserve, Reinsurance, Introduction to ruin theory and Renewal Process.

**Unit II**

Individual and Collective Model, Compound Distributions, Claim Number, Distributions Recursive Computation Methods, Approximation by Compound Distribution, Cramer-Lundberg theory for Heavy tailed distributions.

**Unit III**

Ruin Theory: Discrete Time Ruin Theory, Continuous Time Ruin Theory and Lundberg's inequality in discrete and continuous time. Distribution of deficit. Sparre Andersen Model Renewal Theory: Renewal Process, Renewal equations, weighted renewal functions, A Blackwell-Type Renewal Theorem

**Unit IV**

Detailed study of recent papers related to the topic as suggested by the supervisors, and at least two seminars.

**References**


1. Rolski T., Schmidli H., Schmidt V. Teugels J (1999): Stochastic Processes for Insurance and Finance, John Wiley and sons.
2. Embrechts P., Kluppelberg C. and Mikosch T. (1997): Modelling Extremal Events for Insurance and Finance, Springer – Verlag.

**STA 704-Reliability Theory and Survival Analysis (Credit-4)**

**Objective :** The main objective is to introduce different concepts and their interpretation in reliability and survival analysis.

**Learning Outcomes :**
After the completion of the course students will learn

- concept of reliability and its various measure.
- Multivariate system of reliability.
- the censoring scheme and likelihood function and its estimation.
- Non-parametric estimation in lifetime data.

**Unit I**
Reliability: Concept, various measures of Reliability, Reliability of systems. Life time models: Concept, classes of life time distributions, failure rate, different classes of life time distribution and their interrelationships, mean residual time.

**Unit II**
Availability, interval reliability, system reliability. Multistate system of reliabilities, Multivariate life time distributions and their failure rates.

**Unit III**
Estimation of Survival function: The Censoring mechanisms. Likelihood function under censoring. Estimation under censoring, The E–M algorithm.

**Unit IV**
Nonparametric estimation: Kaplan–Meier estimators. Self consistency, Nelson-Aalen estimator of cumulative hazard function, Log rank and Tarone-Ware tests. Competing risks models. Semi-parametric Inference: Cox proportional hazards model. The partial likelihood and estimation of regression coefficients, Estimation of the baseline hazard function.

**References:**


1. Barlow and Proschan (1975), Statistical Theory of Reliability and Life testing: Probability Models
2. Klien, J.P. and Moeschberger, M.L. (2003). Survival Analysis: Techniques for censored and Truncated Data. 2/e. Springer


Additional References:


1. Elandt-Johnson, Regina C; Johnson, Norman L. (1999). Survival models and data analysis. Classics Library ed. – John Wiley & Sons.
2. Kalbfleisch, J.D. and Prentice, R. L (2002), The Statistical Analysis of Failure Time Data, 2nd edition, J. Wiley, New York.
3. Klein, J.P (2003): Survival Analysis, Springer Verlag.
4. Macdonald, A.S., An Actuarial Survey of Statistical Models for Decrement
5. Miller, J (1980), Survival Analysis, J. Wiley, New York.
6. Nelson, W (1982), Applied Life Data Analysis, J. Wiley, New York.

**STA 705- Advanced Time Series Analysis (Credit-4)**

**Objective:**
To introduce a variety of statistical models for time series and cover the main methods for analysing these models.

**Learning Outcomes**
At the end of the course, the student should be able to Compute and interpret the properties of ARIMA and GARCH models. Choose an appropriate ARIMA/GARCH model for a given set of data and fit the model using various techniques. Compute forecasts for a variety of linear methods and models. Students should also understand the differences between cross-sections and time series, and those specific economic problems, which occur while working with panel and multivariate data.

**Unit I**
Stationarity and invertibility conditions, ARIMA(p,d,q) model, estimation of parameters for AR, MA, ARMA and ARIMA processes, identification of processes with ACF PACF, Model order estimation techniques-AIC, AICC, BIC, EDC, FPE and forecasting. Forms of non stationarity in time series, Unit root: Dickey-Fuller, augmented Dickey-Fuller and Phillips-Perron tests.

**Unit II**
Multivariate time series processes and their properties, Vector autoregressive (VAR), vector moving average (VMA) and vector autoregressive moving average (VARMA) processes.

**Unit III**
Panel data models: Balance and unbalance panel data, estimation in random effect and fixed effect models. ARCH and GARCH processes and models with ARCH, GARCH errors.

**Unit IV**
A detailed analysis of time series data based on the above techniques in both simulated and real data from NSE, BSE, RBI, etc must be submitted with in the week of completion teaching of the course. Presentation of five recently published paper in the area of time series, preference will be given to the papers are having empirical study of data of Indian origin

**Unit V**
Recent developments on time series will be discussed and the content will be decided by Instructor and researcher like outlier, clustering, handling of missing observations, Bayesian analysis of time series.

**References:**

1. Box, G.E.P. and G.M. Jenkins. Time Series Analysis, Forecasting and Control.
2. Brockwell, P.J. and Davis, R.A.. Time Series: Theory and Methods (Second Edition), Springer-Verlag.
3. Chatfield, C.: The Analysis of Time Series: Theory and Practice.
4. Granger, C.W.J. and Newbold, Forecasting Econometric Time Series, Third Edition, Academic Press.
5. Kirchgassner, G. and Wolters,J. Introduction to Modern Time Series Analysis, Springer.
6. Montgomery, D.C. and Johnson, L.A. Forecasting and Time Series Analysis, McGraw Hill.
7. William W S W: Time Series Analysis : Univariate and Multivariate Gregory C, Elements of Multivariate Time Series Analysis, Springer Series in Statistics
8. Hamilton, J D: Time Series Analysis, Princeton University Press
9. Harvey, A C: Time Series Models
10. Harvey, A C: The Econometric Analysis of Time Series, Pearson education,
11. Enders W, Applied Econometric Times Series, Wiley Series in Probability and Statistics,
12. Tsay R S, Analysis of Financial Time Series, (Wiley Series in Probability and Statistics)

**STA 706-Sampling Techniques** **(Credit-4)**

**Objectives:** The main objective of this course is to provide the knowledge of concept of sample and population in statistics and also elaborate in dept knowledge of sampling schemes and estimation of population parameters.

**Learning Outcomes:**

- On successful completion of the course, the student must be able to
  - use different sampling techniques.
  - construct strata, able to do deep stratification, post stratification
  - use Horvitz Thompson estimator to estimate parameters
- use of double sampling scheme, PPS sampling
- understand non-sampling errors
- use some estimation techniques with special reference to non-response problems

**Unit I:**

Fixed population and super-population approaches. Distinct features of finite population sampling, Probability sampling design and estimators along with basic statistical properties. Review of some important results in SRSWOR and SRSWR.

**Unit II:**

Real life situations where stratification can be used, Description of stratified sampling methodwhere sample is drawn from individual stratum using SRSWOR method. Estimator of population mean, population total, derivation of its expectation. Problem of allocation: Proportional allocation, Neyman's allocation and optimum allocation, derivation of the expressions for the standard errors of the above estimators when these allocations are used.Gain in precision due to stratification, comparison with SRSWOR, stratification with proportional allocation and stratification with optimum allocation. Cost and variance analysisin stratified random sampling, Post stratification, Double sampling with post stratification,Deep stratification, Controlled sampling.

**Unit III:**

Unequal probability sampling: PPSWR/WOR methods (including Lahiri's scheme) and Des Rajestimator, Murthy estimator (for n=2). Horvitz Thompson Estimator of finite populationtotal/mean, Expression for Variance (HTE) and its unbiased estimator, Issue of non-negativevariance estimation. Unbiased and almost unbiased ratio type estimator.

**Unit IV:**

Double sampling scheme, some double sampling estimators for mean using auxiliarycharacter (Ratio, regression and product) method of estimation, Some unbiased ratio typeestimators for population mean, Concept of cluster sampling, two stage sampling, Two phasesampling, Non-sampling error with special reference to non-response problems.

**References:**


1. Cochran, W.G: Sampling Techniques, Wiley Eastern Ltd., New Delhi.
2. Sukhatme, P.V., Sukhatme, B.V. and Ashok A. : Sampling Theory of Surveys with Applications,Indian Society of Agricultural Statistics, New Delhi.
3. Murthy, M.N: Sampling Methods, Indian Statistical Institute, Kolkata.
4. Daroga Singh and Choudhary F.S.; Theory and Analysis of Sample Survey Designs, Wiley EasternLtd., New Delhi.
5. Mukhopadhay, Parimal: Theory and Methods of Survey Sampling, Prentice Hall.

## STA 707-Statistical Quality Control

**Credit-4**

**OBJECTIVES**:

The main purpose of this paper is to introduce the most important field of applied statistics that contributes to quality control in almost all industries.

**Learning outcomes**

By the end of this course students are expected to be able to

a. Apply and use the basic concepts related to quality control
b. Determine sample size so as the estimator to have a desired precision
c. Use appropriate sampling inspection plan and determine the estimate of the parameters for optimum sample sizes.

**Unit I**

Introduction: Concepts of quality and quality control, Different types of quality measure. Rational subgroups and technique of control charts. -sigma control limits and probability limits. Process control and product control.

**Unit II**

Process control: Control Charts and their uses. Uses of subgroup sizes. Construction of control charts by attributes including unequal subgroup size and variables (, ). Interpretation of nonrandom patters points.

**Unit III**

Product control: Producer's risk, Consumer's risk. Acceptance sampling plan, Single and double sampling plans by attributes, their OC, ASN and ATI, LTPD and AOQL. Single sampling plan for variables (one-sided specification, known and unknown cases). Use of IS plans and tables.

**Unit IV**

Moving average and exponentially weighted moving average charts. Cu-sum charts using V-masks and decision intervals. Economic design of chart. Continuous sampling plans of Dodge type and Wald-Wolfowitz type and their properties. Bayesian sampling plans. Process capability indices.

**References:**


1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2001): Fundamentals of Statistics (V-2), World Press.
2. Montgomery, D.C. (2005): Introduction to Statistical Quality Control, John Wiley.
3. Wetherill, G.B. and Brown, D.W. (1991): Statistical Process Control Theory and Practice, Chapman & Hall.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamental of Applied Statistics, SULTAN CHAND AND SONS, New Delhi.

**STA 708-Frailty Models** **Credit-4**

**Objective:**
Introduce students to Standard frailty models for simple survival, recurrent and clustered data (models, estimation, dynamic prediction and illustrations).

**Learning Outcome**
Student can able to understand Extensions of different frailty models (models, estimation and illustrations).

**Unit I**
Introduction: Basic Concepts in Survival Analysis, Censoring and Truncation, Parametric Models (Exponential distribution, Weibull distribution, Log-logistic distribution, Gompertz distribution, Log-normal distribution, Gamma distribution, Pareto distribution), Regression Models( Proportional hazards model, Accelerated failure time model), Identifiability Problems., Nonparametric and Semi parametric Models: Empirical Survival Function, Graphical Plotting (Probability Plotting, Hazard and Cumulative Hazard Plotting, Exponential and Weibull Hazard Plots), Estimation of Survival and Hazard Functions ( Kaplan Meier estimator, Nelson Aalen estimator), Comparison between Two Survival Functions , Cox's Proportional Hazards Model

**Unit II**
The Frailty Concept, Various Frailty Models, Estimation Methods for Shared Frailty Models, Analysis of Survival Data in Shared Frailty Models, Tests of Hypotheses in Frailty Models, Shared Frailty in Bivariate Exponential and Weibull Models, Frailty Models Based n L'eey Processes.

**Unit III**
Bivariate Frailty Models and Estimation Methods, Correlated Frailty Models, Additive Frailty Models, Identifiability of Bivariate Frailty Models.

**Unit IV**
The semi parametric frailty model, Multifrailty and multilevel models, Copula Models, Different Aspects of Frailty Modeling, Extensions of the frailty model.

**References :**

1. Frailty Models in Survival Analysis by Andreas Wienke(2011).
2. Modeling Survival Data Using Frailty Models by David D. Hanagal(2011)
3. The Frailty Model by Luc Duchateau and Paul Janssen(2008)

**STA 709-Advance Bayesian Inference**

**Credit -4**

**Objective**: This paper has been designed for the purpose to explore the new paradigm of estimation procedure, named as Bayesian estimation.

**Learning Outcome**:

1. The students will learn the fundamentals of Bayesian inference.
2. Students will acquire the knowledge about different Bayes computational techniques to approximate the posterior expectations.

**Unit I**

Basic elements of Statistical Decision Problem. Expected loss, decision rules (nonrandomized and randomized), decision principles, inference as decision problem, optimal decision rules.Bayes and minimax decision rule. Admissibility of minimax rules and Bayes rules.

**Unit II**

Overview classical and Bayesian paradigms; Bayes theorem and its applications. Advantage of Bayesian inference, Prior distribution, Posterior distribution, Subjective probability and its uses for determination of prior distribution. Importance of non-informative priors, improper priors, invariant priors. Conjugate priors, construction of conjugate families using sufficient statistics, hierarchical priors, Parametric Empirical Bayes.

**Unit III**

Bayes estimation: Concept of Loss functions, type of Loss functions: Types: 0-1; Absolute error; Squared error loss functions; Asymmetric loss functions such as LINEX and General Entropy loss functions; Mixture of loss functions, risk function, Bayes credible intervals, highest posterior density intervals, Bayes testing, prior and posterior odds ratio, Bayes factor. Comparison with classical procedures.

**Unit IV**

Ideas on Bayesian robustness. Predictive inference for generalized reliability models. Bayesian approximation techniques: Lindley's approximation, T-K approximation, Monte-Carlo optimization, Markov chain Monte Carlo techniques (M-H algorithm and Gibbs Sampler).

**Reference:**


1. Berger, J. O. : Statistical Decision Theory and Bayesian Analysis, Springer Verlag.
2. Robert, C.P. and Casella, G. : Monte Carlo Statistical Methods, Springer Verlag.
3. Leonard, T. and Hsu, J.S.J. : Bayesian Methods, Cambridge University Press.
4. Bernando, J.M. and Smith, A.F.M. : Bayesian Theory, John Wiley and Sons.
5. Robert, C.P. : The Bayesian Choice: A Decision Theoretic Motivation, Springer.
6. Gemerman, D. : Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Chapman Hall.
7. Box, G.P. and Tiao, G. C.: Bayesian Inference in Statistical Analysis, Addison-Wesley.

**STA 710-Extreme Value Theory**

**Credit-04**

**Objective:**
The main objective of this course is to acquaint the students with probability theoretical concepts in an extreme value theory.

**Learning Outcome:** The students will learn

- Limit laws of maxima of sample and based on its limiting behavior identifies its max. domain attractions.
- Different method of estimation including graphical methods of tail index.
- Construction of extreme value distributions and its application in different disciplines.

**Unit 1:**

Fluctuations of Maxima -Limit Probabilities for Maxima, Weak convergence of maxima under affine transformations Maximum Domains of attraction and Norming constants – The maximum domains of attractions of extreme value distributions. The generalised extreme value distribution and Generalised Pareto distribution, Almost sure behaviour of maxima. Fluctuations of upper order statistics – Order statistics, The limit distribution of upper order statistics, The limit distribution of randomly indexed upper order statistics.

**Unit 2:**

Statistical Methods for Extremal Events – Introduction, Exploratory data analysis for extremes – Probability and Quantile plots, The mean excess function, Gumbel's method of exceedences, The return period, Records as an exploratory tool, The ratio of maximum and sum. Parameter estimation for the Generalised extreme value distribution – Maximum likelihood estimation, Method of probability weighted moments, Tail and Quantile estimation, a first go. Estimation under maximum domain of attraction conditions – Introduction, Estimating the shape parameter, Estimating the norming constants, Tail and Quantile estimation. Fitting excesses over a Threshold – Fitting the GPD, An application to Real data. Chapter 9 in R. D. Reiss and M Thomas (2001): Multivariate maxima – Non Parametric and Parametric extreme value models, The Gumbel-McFadden model, Estimation in extreme value models.

**Unit 3:**

Extreme Value Theory -Domains of Attraction, von Mises Conditions under Power Normalization and p-Max Stable Laws, Heavy and Super-Heavy Tail Analysis. Basic Theory of Multivariate Maxima -Limiting Distributions of Multivariate Maxima, Representations and Dependence Functions, Pickands Representation and Dependence Function. Threshold Selection, Parametric Estimation Procedures a brief overview, Testing in GPD Models.

**Unit 4:**

Statistical Models for univariate and bivariate extreme distribution and their generalizations. Applications of Extreme distribution in Insurance, Finance, Telecommunications, and the Environment book.

**References:**


1. Reiss, R.D. and Thomas, M (2001): Statistical Analysis of Extreme Values , Birkhauser verlag.
2. Embrechts, P., Kluppelberg, C. and Mikosch, T. (1997), Modelling Extremal Events for Insurance and Finance, Springer, New York.
3. Michael Falk, Jurg Husler, Reiss, R.D (2010): Laws of Small Numbers: Extremes and Rare Events, Third edition, Birkhauser Verlag.
4. Bärbel Finkenstädt and Holger Rootzén (2001): Extreme Values in Finance, Telecommunications, and the Environment, Chapman and Hall/ CRC Press.

## STA 711: Total Quality Management

**Credit: 04**

### Objective

The field of quality management keeps advancing in both depth and breadth with the scope of application in manufacturing and services. Apply and use the basic concepts related to quality control and quality management. The purpose of this course is to put quality management into perspective, and to highlight its critical importance, as well as to present in-depth ideas on different methodologies, tools and techniques proposed for product and process improvement.

### Course Outline

**Unit 1-** Evolution of Quality Management, Concept of Product and Service Quality, Dimensions of Quality, Philosophy of Deming's, Juran's Quality and Crosby's Quality, Quality Cost.

**Unit 2-** Introduction to Process Quality, Graphical and Statistical Techniques for Process Quality Improvement, Graphical toolsfor data representation, 7 QC tools, Sampling, Sampling distribution, Hypothesis testing, Regression, Control chart, Process Capability Analysis, Measurement system Analysis.

**Unit 3**- Analysis of Variance, Design and Analysis of experiment, Acceptance sampling plan, TQM, Leadership, Lean and JIT Quality Philosophy, Benchmarking, Process failure mode and effect analysis, Service Quality, Six sigma for Process improvement, ISO 9001 and QS 9000, Quality Audit, Quality Circles.

**Unit 4-** Quality Function Deployment, Robust Design and Taguchi Method, Design Failure Mode and Effect Analysis, Product Reliability Analysis, Six Sigma in Product Development.

### References-


1. D. C. Montgomery: Introduction to Statistical Quality Control, John Wiley & Sons, 3rd Edition.
2. Mitra A., Fundamentals of Quality Control and Improvement, PHI, 2nd Ed., 1988.
3. J Evans and W Linsay, The Managementand Control of Quality, 6th Ed., Thomson, 2005.
4. Besterfield, D H et al., Total Quality Management, 3rd Edition, Pearson Education, 2008.
5. D. C. Montgomery: Design and Analysis of Experiments, John Wiley & Sons, 6th Edition, 2004.

**STA 712 : Applied Demography**

**Credit:04**

**Objective**

This paper has been designed to provide the elementary idea about the different types and sources of demography or population data to understand the current trend of population.

**Learning Outcome:**

1. Students will have the knowledge for different population measures.
2. Will learn about different measures of fertility, mortality and migration and related mathematical and stochastic models.
3. It also provides the knowledge about the population projection theory and related methodology for forecasting.

Unit-I

**Sources of demographic data**: Census, CRS, SRS, NSS, National Family Health Surveys (NFHS); District Level Health Surveys (DLHS). Error in census and survey data: Errors of coverage and content, non-response, partial response, reporting errors (voluntary and non-voluntary response errors, heaping due to under and over reporting, recall lapse, memory bias,selection bias, response bias), non-sampling errors.

Unit-II

**Population Projection:** Concept of rates and ratios, incidence and prevalence rates, cross- sectional study; case control studies and intervention studies. Prospective and retrospective studies, follow up studies, population exposed to the risk. Population Estimation- Inter-censual and post-censual Methods of Population Projection-mathematical and components methods.

Unit-III

**Fertility Models**: Different measure of fertility, Biology of fertility: Menstruation, menarche and menopause, ovulation, timing of ovulation and risk of conception, gestation, fecundability. Termination of pregnancy - Spontaneous and induced abortion.Post-partum amenorrhea period.Socio-cultural factors affecting these parameters, NRR, GRR.

Models for number of births and conceptions in a given time period. Birth Intervals - first birth interval, closed birth interval, open birth interval, interior birth interval. Truncation effect on birth intervals.Sampling frame as a determinant of distribution of birth intervals. Concept of nuptiality and its measurement, Age at marriage, SMAM.

Unit-IV

**Migration**: Differential and determinants of migration, Migration as a response to socio-economic change. Effect of migration on places of origin and destination.Theories of migration –Theories by Raventien, Lee and Peterson.International migration.Concept and definition of urbanization.

**Mortality**: Different measures of mortality, Standard death rates, Differential and determinants, IMR and its estimation, Abridged life tables, Model life tables.

**Reference books:**


1. Coale A.J. (1972), “The Growth and Structure of Human Population: A Mathematical Investigation” Princeton: University Press.
2. Ram Kumar R. (1986), “Technical Demography”, Wiley Eastern Limited, New Delhi.
3. Spiegelman M. (1955), “Introduction to Demography”, Harvard University Press.
4. Sundaram, KR, Dwivedi SN and Sreenivas, V., Medical Statistics: Principles and Methods by, 2nd Edition, 2015. Wolters and Kluwer (Health), New Delhi.
5. Pathak K.B. and Ram F. (1998), “Techniques of Demographic Analysis”. Himalaya Publishing House, New Delhi 2 nd Edition.

## STA 713: Advanced Computational Techniques

**Credits 4**

### Objective

The course is built around statistical models and computational tools in cases where computer assisted computations are essential.

### Learning outcomes

Student can use the stochastic simulation as a computational tool, bayesian inference and will understand Markov chain Monte Carlo simulation methods from both applied and theoretical viewpoints. Student can able to understand the connections and interplay between statistical modeling and applied problem solving, as well as computational and theoretical aspects of the models.

### Unit-1

Random Number and Variable Generation: uniform random number generators, modular arithmetic, combination generators, discrete and continuous random variables, inverse transform method, acceptance-rejection method, tilted sampling. Monte Carlo Integration: general formulation, importance sampling, variance reduction, numerical integration and differentiation

### Unit-2

Resampling Techniques: Re sampling paradigms, bias-variance trade-off. Bootstrap methods, estimation of sampling distribution, confidence interval, variance stabilizing transformation. Jackknife and cross-validation. Jackknife in sample surveys. Jackknife in regression under heteroscedasticity. Permutation tests.

### Unit-3

Missing Values and Imputations Techniques: Missing values and types of missingness,imputations methods for missing values, single and multiple imputations. EM Algorithm and Applications: EM algorithm for incomplete data,EM algorithm for mixture models,EM algorithm for missing values, stochastic EM algorithm. Application to Statistical Problems.

### Unit-4

Bayesian computing, Markov Chain Monte Carlo. Simulation using MCMC, Particle filtering, MCMC methods for missing values. Application to Statistical Problems.

### References


1. Buuren, Stef van (2012). Flexible Imputation of Missing Data. Chapman and Hall.
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