Gujarat University

Choice Based Credit System (CBCS)

Syllabus for Statistics (UG)

Third Year B.Sc.

Semester V and VI

Effective from June 2013

Gujarat University

B.Sc. Statistics Syllabus

Semester V

STA- 301

Distribution Theory - I

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Discrete Probability Distribution

- Geometric Distribution
- Negative Binomial Distribution
- Derivation, basic properties of these distributions – Mean, Variance, moment generating function and moments, cumulants generating function,
- Applications and examples of these distributions.

Unit 2: Truncated distributions

- Truncation - Meaning and use, types of truncations
- Truncated distribution as conditional distribution, truncation to the right, to the left and on both sides.
- Binomial distribution B(n p) left truncated at X = 0, (value zero not observable), derivation of its p.m.f, mean, variance.
- Poisson distribution P(λ) left truncated at X = 0 (value zero not observable), derivation of its p.m.f, mean, variance.
- Normal distribution N(μ, σ^2) truncated to the left of X = a and to the right of X = b, its p.d.f. and mean.
- Examples and problems based on these Truncated Distributions,

Unit 3: Power Series Distribution

- Concept and definition
- Moments – raw moments and central moments, recurrent relations for raw and central moments of power series distribution
- Moment generating function, cumulant generating function,
- Discrete distributions as a special cases – binomial distribution, Poisson distribution, Negative binomial distribution, geometric distribution, log series distribution

Unit 4: Order Statistics

- Definition and uses of order statistics

- Distribution of largest and smallest order statistics
- Distribution of sample range
- Examples based on uniform, rectangular and exponential distributions

REFERENCES:

- Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
- Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory Of Statistics, McGraw Hill.
- Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
- Rohtagi, V.K. (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
- Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Wiley Series in Prob. Mathematical Statistics, John Wiley and Sons, New York (International Student Edition).
- Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
- Sheldon.M.Ross : A First Course in Probability -, (Mc Millian publishing Co.)
- S.M. Ross (Elsever): Introduction to Probability and Statistics for Engineers and Scientists-

Semester V

STA- 302

Statistical Inference and Design of Experiment I

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Point Estimation

- Notion of parameter, parameter space,
- General problem of estimating an unknown parameter by point and interval estimation
- Concepts of statistic and estimator

Unit 2: Properties of Estimator

- Properties of an estimators: unbiasedness, consistency, sufficiency, efficiency
- Factorization theorem on sufficiency – discrete case only
- Fisher's information contained in sample and its use in sufficient statistics
- Minimum Variance Unbiased estimator (MVUE) - definition and properties
- Rao Cramer inequality, Rao Blackwell theorem and its use to obtain Minimum Variance Unbiased estimators

Unit 3: Methods of Estimation

- Method of moments
- Method of maximum likelihood with properties (statements only)
- Method of scoring

Unit 4: Analysis Of Variance

- Idea of variation – total variation, variation within and variation between
- One way classification – purpose and Analysis with equal number of observations per cell using ANOVA technique
- Two way classification – purpose and Analysis with equal number of observations per cell using ANOVA technique
- Expected values of sum of squares for both one and two way classifications
- Applications of one and two way classifications

Design of Experiments

- Concept of treatment, plot, block, yield, Shapes and Sizes of Plots and Blocks.
- Principles of experimental design: Randomization, Replication and Local Control, Uniformity trials,

- Basic Design: Idea of Linear model, Completely Randomized Design (CRD), Frame of this design, statistical analysis of this design, merits and demerits.

REFERENCES:

- Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
- K.R. Koch (1987) : Parameter Estimation and Hypothesis Testing in Linear Models,
- Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory Of Statistics, McGraw Hill.
- Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
- Rohtagi, V.K. (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
- Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Wiley Series in Prob. Mathematical Statistics, John Wiley and Sons, New York (International Student Edition).
- Goon, A.M., Gupta,M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, WorldPress, Calcutta.
- A First Course in Probability - Sheldon.M.Ross, (Mc Millian publishing Co.)
- Introduction to Probability and Statistics for Engineers and Scientists- S.M. Ross (Elsever)
- Stuart G & Ord J.K. (1991): Advanced Theory of Statistics (Vol 2), Charles Griffin
- M.N. Das & N. Giri :Design of experiments, (Wiley Eastern Ltd)
- Kempthorne : Design of Experiments
- Montgomery D.C. (1976): Design and Analysis of Experiments, John Wiley
- Cochran W.G. & Cox G.M. (1957): Experimental Designs, John Wiley
- Federer W.T. (1975): Experimental Designs – Theory and Application, Oxford & IBH
- Mukhopadhyay P. (1999): Applied Statistics
- D. Raghavarao : Construction and Combinatorial Problems in Design of Experiments
- A. Dean & V. Daniel : Design & Analysis of Experiments.

- L.M. Robert, F.G. Richard & L.H.James (2003): Statistical Design & Analysis of Experiments (2nd Ed.), Wiley.
- M.N. Das & N. Giri : Design of experiments, (Wiley Eastern Ltd)
- Kempthorne :Design of Experiments,
- Montgomery D.C. (1976): Design and Analysis of Experiments, John Wiley
- Cochran W.G. & Cox G.M. (1957): Experimental Designs, John Wiley
- Federer W.T. (1975): Experimental Designs – Theory and Application, Oxford & IBH

Semester V

STA- 303

Sampling Techniques

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Simple Random Sampling

Simple Random Sampling with and without replacement and their properties. Methods of selecting a simple random sample. Estimation of population mean, total and proportion. Standard error and estimation of standard errors. Confidence Limits for Population Mean and Total. Estimation of sample size.

Unit 2: Stratified Random Sampling

Estimation of population mean and total, standard error of estimators and estimation of standard errors. Allocation - Proportional, Neyman and Optimum allocations for fixed precision. Determination of sample sizes when (i) variance of stratified mean is known and (ii) when total cost of sampling (C) is known, Comparison between stratified sampling and SRS.

Unit 3: Systematic Sampling

Advantages and limitations, estimation of the population mean and standard error of the estimator. Comparison of systematic sampling (N = nk) with SRSWOR and stratified sampling.

Unit 4: Two Stage Sampling

Estimator, variance of estimator. Unbiased estimator of variance of estimator. Estimation of m_{opt} and n_{opt}.

Reference Books:

- Murthy.M.N : Sampling Theory and Methods, (Statistical Probability Society , Calcutta)
- Cochran.W.G: Sampling Techniques (Wiley Eastern Ltd)
- Desraj: Sampling Theory, (Tata Mc Graw Hill)
- D.Singh and F.S.Chaudhary: Theory and Analysis of Sample survey, (John Wiley and Sons)
- Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall.
- Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. II, WorldPress, Calcutta.
- Mukhopadhyay P. (1999): Applied Statistics

Semester V

STA- 304

Exact Sampling Distributions and their applications

HOURS PER	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Chi square distribution and its applications

- Concepts of population, parameter, random sample from a distribution, statistic and its sampling distribution, definition of Chi-square variate
- Applications of Chi square test
- To test the significance of population variance
- To test the goodness of fit
- To test homogeneity and independence in a contingency table.

Unit 2: t- distribution and its applications

- Definition and derivation of t – distribution
- Student's t and Fisher's t, and relationship between them
- Other properties of t distribution
- General idea about the derivation of the distribution of sample correlation coefficient
- Application of t – distribution

Unit 3: F- distribution

- Definition and derivation of F – distribution
- Other properties of F distribution
- Application of F – distribution
- Derivation of Z - Distribution and related properties
- Relation between Chi-square, t and F distributions

Unit 4:Compound distribution

- Concept and definition of Compound distribution
- Negative binomial distribution as compound distribution of (i) Poisson ^ Gamma distributions (ii) Binomial ^ Poisson distributions **(L)**

REFERENCES :

- Gibbons, J.D. (1985) : Nonparametric Statistical Inference, 2nd ed., Marcel Dekker, Inc.
- Randles, R.H. and Wolfe, D.A. (1979) Introduction to the Theory of Nonparametric
- Statistics, John Wiley and Sons, Inc.

- Hajek, J. and Sidak, Z. (1967) : Theory of Rank Tests, Academic Press.
- Siegel S.: Non Parametric Methods for the Behavioral Sciences. International Student Ed. McGraw Hill Kogakusha Ltd.
- J.D. Gibbons: Non Parametric Statistical Inference, McGraw Hill Book Company, New York.
- Daniel: Applied Non Parametric Statistics, Houghton Mifflin Company Roston.
- Kanti Swarup, Gupta, P.K. and Singh, M.M. (1985): Operations Research, Sultan Chand and Sons.
- Taha, H.A. (1976) : Operational Research : An Introduction, 2nd Ed.
- Philips, D.T., Ravindran, A. And Solberg, J. (1976): Operations Research, Principles and Practice.

ELECTIVE COURSE I

STA-305

STATISTICS USING R

HOUR PER WEEK	CREDIT	EXAM HRS
3	2	3

Unit I: **Introduction to R**

R as a Statistical Software and language, R preliminaries, Method of data input, Data accessing or indexing, Data frames and lists, Functions, Graphics with R, Saving, Storing and retrieving work, work space and files, using scripts, using packages.

Descriptive Statistics Using R – Diagrammatic representation of data, Graphical representation of data, Measures of central tendency, Measures of dispersion, Measures of skewness and Kurtosis, Selection of representative samples.

Unit II: **Probability and Probability distributions using R** – Probability; definition and properties, probability distributions, some special discrete distributions (Binomial, Poisson), Continuous probability distribution, some special continuous distributions (Normal, exponential)

Methods for generating random variables – Introduction, Random generation of common probability distribution in R, the inverse method, the acceptance rejection methods, transformation methods, sums and mixture, Poisson distribution.

Unit III: **Correlation and Regression Analysis** – Correlation, Inference procedures for correlation coefficient, Linear Regression, Inference Procedures for simple linear model, validation of linear regression model

Unit IV: **Monte Carlo methods in estimation and Testing** – Monte Carlo estimation and standard error, estimation of MSE, estimating a confidence interval, Monte Carlo methods for hypothesis test, Empirical type I error rate, Power of a test, Comparison of powers of two tests.

Statistical Inference – Sampling distribution of the sample mean, Estimation of parameters, plots to check normality, Hypothesis testing, Goodness of fit, one way ANOVA.

REFERENCES:

1. Statistics Using R - Sudha .G. Purohit et al. (2008) (Narosa Publishing House)

2. Statistical Computing with R - Maria.L. Rizzo (2007) (Chapman& Hall/CRC)

ELECTIVE COURSE II

STA-305

STATISTICAL ECOLOGY

HOUR PER WEEK	CREDIT	EXAM HRS
3	2	3

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1) Population Dynamics

Introduction: Ecology, Statistical Ecology.

1.1 Linear Growth dNt/dt = C, Interpretation and limitation.

1.2 Exponential Model: Solving dNt/dt = KNt , K > 0,K<0 cases. Properties, Interpretation, Scope and Limitation.

1.3 Logistic growth model :Density dependence, solving differential equation

1.4 dN t/dt = a.Nt (K-N t)Properties ,carrying Capacity, Interpretation, Scope and Limitation.

1.5 Geompertz Curve: Solving Differential equation dN t/dt = a. log (K/N t), Asymptotically stable Equilibrium ,Properties, Interpretation, Scope and Limitation. Fitting the above growth models to data by linearization and regression.

1.6 **Life tables :** Force of mortality stable population and stationary population. Cohort, columns of life table, interrelation between columns interpretation, construction of life table, uses and application.

1.7 Leslie matrix Models: fecundity and survival matrix, nt =Mt n0,future projections, stable age distribution, interpretation of largest sign value of M.

2) Smoothing Procedures

2.1 Poisson forest, Aggregated, Regular spatial point pattern, estimation of population density by quadrate sampling, nearest neighbor distances (Point to individual, individual to individual), i-th order nearest neighbor distance.

2.2 Line transect method : Drawing random line transect, exponential detection function, mle of population density, other detection functions.

2.3 Capture –recapture models: Closed population, Open population, Peterson estimator for single recapture, Multiple captures, irative method to find mle of N, Population size.

2.4 Removal method :Zippin's estimator for closed population.

3) Diversity Indices

3.1 Concept of Biodiversity, need to protect it.

3.2 Richness indices, Simpson's index, Shannon's index.

3.3 Rare fraction Curves, Real life examples for computing these indices.

4) Distribution Models

4.1 Use of geometric distribution, lognormal distribution in ecology.

REFERENCES

- Pielou, E.C. (1977):An Introduction to Mathematical Ecology, Wiley.
- Seber, G.A.F. (1982): The estimation of animal abundance and related parameters, C. Griffin.
- Ludwig,J.A. and Regnold J.F.: Statistical Ecology, A primer on methods and computing.
- Gore,A.P. and Prajpe, S.A. : A First Course on mathematical and Statistical Ecology.

STA-306

Practical Paper I (Part A)

(Based on STA 301 and STA302)

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
3	*2.5*	*3*

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1. Fitting of Negative Binomial distribution
2. Drawing of random sample from Negative Binomial distribution
3. Fitting of Geometric distribution
4. Drawing of random sample from Geometric distribution
5. Fitting of truncated Binomial distribution (truncated at X=0 only) and related problems
6. Fitting of truncated Poisson distribution (truncated at X=0 only) and related problems
7. Problems based on Negative Binomial and Geometric distributions
8. Method of moments of finding estimator

- Bernoulli, Binomial and Poisson Distribution.
- Truncated Binomial and Truncated Poisson Distributions (Truncated at X = 0 only)
- Exponential, Beta , Gamma, Normal distributions.

9. Method of Maximum Likelihood of finding estimator

- Bernoulli, Binomial and Poisson distribution.
- Truncated Binomial and Truncated Poisson Distributions (Truncated at X = 0 only)
- Exponential, Beta , Gamma, Normal distributions. Method of maximum likely estimation
- Use of order statistics for Continuous uniform and rectangular distributions (where range of a random variable depends on parameter (s))

10. Statistical analysis of One – way classification
11. Statistical analysis of Two – way classification
12. Statistical analysis of Completely Randomized Design, comparison of two treatments.

STA-306 Paper I (Part B)

(Based on STA 301 and STA302)

HOURS PER WEEK	***EXAM HRS***
3	***3***

Statistics Practical based on* STA 301 and STA 302 *using Microsoft Excel

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1. Fitting of Negative Binomial distribution
2. Drawing of random sample from Negative Binomial distribution
3. Fitting of Geometric distribution
4. Drawing of random sample from Geometric distribution
5. Fitting of truncated Binomial distribution (truncated at X=0 only) and related problems
6. Fitting of truncated Poisson distribution (truncated at X=0 only) and related problems
7. Problems based on Negative Binomial and Geometric distributions
8. Method of moments of finding estimator

- Bernoulli, Binomial and Poisson Distribution.
- Truncated Binomial and Truncated Poisson Distributions (Truncated at X = 0 only)
- Exponential, Beta , Gamma, Normal distributions.

9. Statistical analysis of One – way classification
10. Statistical analysis of Two – way classification

    Statistical analysis of Completely Randomized Design, comparison of two treatments.

STA-306 Paper II (Part A)

(Based on STA 303 and STA 304)

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
3	*2.5*	*3*

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1. Verification of identities of Simple random sampling based on finite population units.
2. Determination of sample size for Simple Random Sampling.
3. Verification of identities of Stratified random sampling for given data.
4. Calculation of sample sizes under (i) equal, (ii) proportional and (iii) Optimum (Neyman) Allocations and comparison of variance of stratified mean under these allocations.
5. Estimation of sample sizes under cases when (i) Variance of stratified mean is known and (ii) total cost of sampling is given.
   Comparison of efficiency of Stratified Random Sampling with Simple Random Sampling and gain due to stratification.
6. Verification of identities of Systematic sampling for given data.
   Comparison of efficiency of Systematic sampling with respect to Stratified Random Sampling and Simple Random
7. Verification of identities of Two stage sampling.
8. Simple problems based on Simple Random Sampling, Stratified Sampling and Two Stage Sampling.
9. Applications of Chi – square distribution

- To test the significance of Population Variance.
- To test significance of hypothesis about homogeneity of observed and expected frequencies.
- To test independence of attributes.

10. Applications of t – distribution

- To test significance of Single mean
- To test significance of difference of two means
- To test significance of observed correlation coefficient (H_o: $\rho = 0$)
- To test significance of observed partial correlation coefficient (H_o: $\rho_{ij.k} = 0$)

11. Applications of F – distribution

- To test homogeneity of population variances

- To test significance of multiple correlation coefficient

12. Application of Z distribution

- To test significance of correlation coefficient (H_o: $\rho \neq 0$)
- To test significance of more than two sample correlation coefficients and pooled estimate of population correlation coefficient ρ

STA-306 Paper II (Part B)

(Based on STA 303 and STA 304)

HOURS PER WEEK	***EXAM HRS***
3	***3***

Statistics Practical based on* STA 303 and STA304 *using Microsoft Excel

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1. Verification of identities of Simple random sampling based on finite population units.
2. Determination of sample size for Simple Random Sampling.
3. Verification of identities of Stratified random sampling for given data.
4. Calculation of sample sizes under (i) equal, (ii) proportional and (iii) Optimum (Neyman) Allocations and comparison of variance of stratified mean under these allocations.
5. Verification of identities of Systematic sampling for given data.
6. Verification of identities of Two stage sampling.
7. Simple problems based on Simple Random Sampling, Stratified Sampling and Two Stage Sampling.
8. Applications of Chi – square distribution

- To test the significance of Population Variance
- To test significance of hypothesis about homogeneity of observed and expected frequencies
- To test independence of attributes.

9. Applications of t – distribution

- To test significance of Single mean
- To test significance of difference of two means
- To test significance of observed correlation coefficient (H_o: $\rho = 0$)
- To test significance of observed partial correlation coefficient (H_o: $\rho_{ij.k} = 0$)

10. Applications of F – distribution

- To test homogeneity of population variances
- To test significance of multiple correlation coefficient

11. Application of Z distribution

- To test significance of correlation coefficient (H_o: $\rho \neq 0$)

To test significance of more than two sample correlation coefficients and pooled estimate of population correlation coefficient ρ

Semester VI

STA- 307

Distribution Theory - II

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Continuous Probability Distribution

- Cauchy distribution
- Laplace distribution
- Log normal distribution

  Derivation, basic properties of these distributions – Mean, Variance, moment generating function and moments, cumulants generating function,
- Applications and examples of these distributions.

Unit 2: Bivariate Normal distribution

- Review of general properties of Bivariate Distribution
- Detailed study of Bivariate Normal Distribution
- Regression as conditional expectation
- Applications and examples

Unit 3: Tchebychev's Inequality and convergence

- General form of Tchebychev's inequality – other forms of Tchebychev's inequality, Cauchy – Shewart's inequalities and applications with examples
- Convergence – Convergence in probability and convergence in Distribution and their theorems without proof.
- Weak law of large numbers, Bernoulli's weak law of large numbers with simple examples,

Unit 4: Central Limit Theorem and its applications

- Central limit theorem (iid case only) and its applications
- Proof of Lindberg Levy form only. Statement of Liapounoff's Theorem.

REFERENCES:

- Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
- Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory Of Statistics, McGraw Hill.

- Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
- Rohtagi, V.K. (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
- Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Wiley Series in Prob. Mathematical Statistics, John Wiley and Sons, New York (International Student Edition).
- Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
- Sheldon.M.Ross : A First Course in Probability -, (Mc Millian publishing Co.)
- S.M. Ross (Elsever): Introduction to Probability and Statistics for Engineers and Scientists

Semester VI

STA- 308

Statistical Inference and Design of Experiment - II

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Parametric Test

Concept of Statistical Hypothesis, Null and alternative hypotheses, Types of error, level of significance, power of a test, critical region, critical function, randomized and non randomized test, p- value, NP lemma (statement only, and why not proof?), Most powerful test, UMP test, applications of NP Lemma

Unit 2: Likelihood Ratio Test

Likelihood ratio tests for testing for the hypothesis concerning mean and variance of univariate normal distribution, testing hypothesis for equality of two means and testing hypothesis for equality of variances of two univariate normal distributions. Testing for the significance of correlation coefficient.

Unit 3: Nonparametric tests

Concept of a non-parametric tests, difference between parametric and non parametric tests. Sign test for one sample, Wilcoxon signed rank test, Mann-Whitney test, Run test, Median test.

Unit 4: Design of Experiments

Basic designs: Randomized Block Design (RBD), Latin Square Design (LSD): Frame and linear model and Statistical analysis of Randomized Block Design and Latin Square Design (RBD and LSD), merits and demerits of Randomized Block Design and Latin Square Design (RBD and LSD), missing plot techniques for these designs (up to two yield), comparison of efficiency of basic designs (CRD, RBD and LSD).

Factorial experiment

- Concept and need of factorial experiments
- Idea of terms – main and interaction effect, confounding – total and partial,
- Yates' Procedure and Yates' table
- 2^2 and 2^3 factorials - main effects and interactions, their best estimates and testing the significance when underlying design is RBD

REFERENCES:

- Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
- Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory Of Statistics, McGraw Hill.
- Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
- Rohtagi, V.K. (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
- Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Wiley Series in Prob. Mathematical Statistics, John Wiley and Sons, New York (International Student Edition).
- Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, WorldPress, Calcutta.
- Sheldon.M.Ross,: A First Course in Probability - (Mc Millian publishing Co.)
- S.M. Ross (Elsever): Introduction to Probability and Statistics for Engineers and Scientists
- Stuart G & Ord J.K. (1991): Advanced Theory of Statistics (Vol 2), Charles Griffin
- Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, WorldPress, Calcutta.
- M.N. Das & N. Giri : Design of experiments, (Wiley Eastern Ltd)
- Kempthorne :Design of Experiments,
- Montgomery D.C. (1976): Design and Analysis of Experiments, John Wiley
- Cochran W.G. & Cox G.M. (1957): Experimental Designs, John Wiley
- Federer W.T. (1975): Experimental Designs – Theory and Application, Oxford & IBH
- Mukhopadhyay P. (1999): Applied Statistics

Semester VI

STA- 309

Statistical Quality Control

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1: Introduction

Importance of Statistical methods in industrial research, Importance of SQC, Meaning and specification of item and lot qualities, Chance and Assignable Causes of Quality Variation. Determination of tolerance limits. Theory of runs. Criterion for detecting lack of control.

Unit 2: Control Charts

Control Charts - Basis, Rational subgroups, natural tolerance and specification limits. Construction of $\bar{X}$ chart, R charts, S chart and their interpretations. OC function of $\bar{X}$ chart only. Construction of p, np, c, u charts and their interpretations.

Unit 3: Acceptance Sampling Plans for attributes

Principle of accepting sampling, stipulation of good and bad lots. Single sampling and double sampling plans for attributes and AQL, LTPD, Producer's risk and Consumer's risk, OC curve, AOQ, AOQL, ASN, ATI for SSP only. Construction of Single Sampling Plan given two points on the OC curve.

Unit 4: Acceptance Sampling Plans for variables

Sampling plan for variables (i) when LCL is specified (a) σ is known, (b) σ is unknown, (ii) when UCL is specified (a) σ is known, (b) σ is unknown

Advantages and disadvantages of sampling inspection plans for variables compare to sampling inspection plans for attributes.

REFERENCES:

- Montgomery, D.C. (2001): Introduction to Statistical Quality Control, Wiley.
- Grant, E.L. (2000) : Statistical Quality Control, 7th Ed., Tata Mcgraw Hill.
- Ott, E.R. (1975) : Process Quality Control, McGraw Hill.
- Wetherill, G.B. (1977) : Sampling Inspection and Quality Control, Halsted Press.
- Wetherill, G.B. and Brown, D.W. : Statistical Process Control, Theory and Practice,
- Chapman and Hall,
- Brownlee, K. A (1960): Statistical Theory and Methodology in Science and
- Engineering, John Wiley & sons.

Semester VI

STA- 310

Operations Research

HOURS PER WEEK	*CREDIT*	*EXAM HRS*
4	*3*	*3*

Unit 1. Operations Research and Linear Programming

Nature, Scope and Models in Operations Research. Linear programming problems - formulation, solution by - graphical method, simplex algorithm (without proof), Charne's M-technique (without proof). Elementary idea of Duality and related examples.

Unit 2. Transportation and Assignment problems

Transportation problem, Initial solution by north west corner rule, table minimum method and Vogel's method. Stepping stone algorithm and U-V method of solving Transportation problem (without proof). Degenerate transportation problems. Assignment problem. Hungarian algorithm (without proof).

Unit 3. Replacement Theory and Sequencing problems

Concept of Replacement Theory, Replacement model for items which deteriorate with time under increase in maintenance costs increases with time while value of money remains same during the period under considerations, Group replacement of items which fail

Concept of Sequencing, Elementary idea about the basic terms,

Sequencing problem of (i) processing n jobs through two machines

(ii) processing of n jobs through k machines

Unit 4. PERT and CPM :

Project planning with PERT and CPM, drawing of Project network, critical path identification, slack time and float. Calculation of probability of completing the Project within a specified time.

REFERENCES :

- Hillier, F.S. and Liebermann G.J. (1970): Introduction to Operations Research, Tata McGraw.Hill.
- Gass, S.I. (1975) : Linear Programming, Methods and Applications, 4th Ed
- Gross, D. and Harris, C.M.(1974): Fundamentals of Queueing Theory, John Wiley and Sons.
- Sivazlian, B.D. and Stanfel, L.E.(1975): Analysis of Operations Research.

- Kanti Swarup, Gupta, P.K. and Singh, M.M. (1985): Operations Research, Sultan Chand and Sons.
- Taha, H.A. (1976) : Operational Research : An Introduction, 2nd Ed.
- Philips, D.T., Ravindran, A. And Solberg, J. (1976): Operations Research, Principles and Practice.
- Heardly, G. (1962) : Linear Programming
- Gibbons, J.D. (1985) : Nonparametric Statistical Inference, 2nd ed., Marcel Dekker, Inc.
- Randles, R.H. and Wolfe, D.A. (1979) Introduction to the Theory of Nonparametric
- Statistics, John Wiley and Sons, Inc.
- Hajek, J. and Sidak, Z. (1967) : Theory of Rank Tests, Academic Press.
- Siegel S.: Non Parametric Methods for the Behavioral Sciences. International
- Student Ed. McGraw Hill Kogakusha Ltd.

ELECTIVE COURSE I

STA-311

Medical Statistics

HOUR PER WEEK	CREDIT	EXAM HRS
4	2	3

I. Population study

1.1 India's population and census,
1.2 Population growth and models for population growth,
1.3 Birth and death rates,
1.4 Survival function,
1.5 Hazard rate (age specific mortality rate),
1.6 Use of exponential and Weibull distribution for modeling hazard rate.

2. Epidemiology

2.1 Epidemiology.
2.2 Odds, odds ratio, relative risk.
2.3 Estimation of odds ratio (OR), Confidence interval for OR. Relation with parameter in a log it model.
2.4 Symmetry in square contingency tables, collapsing tables and Simpson's paradox

3. Clinical trials-I

3.1 General information on history of drug discovery including Louis Pasteur (rabies and small pox, Ronald Ross and malaria, Alexander Fleming and penicillin, Jonas Salk and polio, Cholera, asthma, diabetes, blood pressure, heart attack, arthritis.
3.2 Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report
3.3 Parallel designs, case control studies, longitudinal studies, safety studies

4. Clinical trials-II

4.1 2 treatments, 2 periods cross over design.
4.2 Bioequivalence and bio-availability, non-inferiority trial
4.3 Practice based medical research, evidence based medicine

REFERENCES

- Course on mathematical and statistical Ecology : Kluwer publishing Holland, A.p . Gore and S. A, Paranjape (200)
- Introduction to Statistical Ecology : M.B. Kulkarni, V.R. Prayag, SIPF Academy, Nasik (2004)

ELECTIVE COURSE II

ACTURIAL SCIENCE PROBABILITY MODELS AND RISK THEORY

HOUR PER WEEK	CREDIT	EXAM HRS
4	2	3

Unit.1

Individual risk model for a short time: Model for individual claim random variables-Sums of independent random variable- Approximation for the distribution of the sum-Application to insurance.

Unit.2

Collective risk models for a single period: The distribution of aggregate claims-Selection of basic distributions-Properties of compound Poisson distributions –Approximations to the distribution of aggregate claims

Unit.3

Collective risk models over an extended period: Claims process-The adjustment coefficient-Discrete time model-The first surplus below the initial level-The maximal aggregate loss

Unit.4

Application of risk theory: Claim amount distributions-Approximating the individual model-Stop-loss re-insurance-The effect of re-insurance on the probability of ruin

REFERENCES:

Institute of Actuaries Act Ed. Study materials

McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance

Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books

Neill, Alistair, Heinemann, (1977): Life contingencies.

Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed

B. Sc. Sem - VI

STA-312 Paper 1 (Part A)

(Based on STA 307 and STA 308)

HOUR PER WEEK	CREDIT	EXAM HRS
3	2.5	3

1. Fitting of Log–Normal distribution
2. Generation of random sample from Log Normal distribution.
3. Generation of random sample from Bivariate normal distribution.
4. Problems based on Testing of Hypothesis:
   To find size of type – I and type – II error, Power of test and power curve, Critical Region,
5. Use of NP Lemma to find MP critical region – Basic Discrete distribution
6. Use of NP Lemma to find MP critical region – Basic Continuous distribution
7. Use of likelihood ratio test to find UMP critical region – Basic Discrete distribution
8. Use of likelihood ratio test to find UMP critical region – Basic Continuous distribution
9. Nonparametric Tests and related problems based on Sign test for one sample, run test, median test, Mann-Whiteny U test, Wilcoxon Signed rank test.
10. Randomised Block and Latin Square Designs
    Statistical Analysis and comparison of treatments, Tukey's test, Bonferroni's test for critical difference among treatments.
11. Estimation of missing yields (upto two missing yields) in Randomised Block and Latin Square Designs, Efficiency of these designs.
12. Statistical Analysis of 2^2 and 2^3 factorial experiments

STA-312 Paper I (Part B)

(Based on STA 307 and STA 308)

HOURS PER WEEK	***EXAM HRS***
3	***3***

Statistics Practical based on* STA 303 and STA304 *using Microsoft Excel

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1. Fitting of Log–Normal distribution
2. Generation of random sample from Log Normal distribution.
3. Generation of random sample from Bivariate normal distribution.
4. Problems based on Testing of Hypothesis:
   To find size of type – I and type – II error, Power of test and power curve, Critical Region,
5. Nonparametric Tests and related problems based on Sign test for one sample, run test, median test, Mann Whiteny U test, Wilcoxon Signed rank test.
6. Randomised Block and Latin Square Designs
   Statistical Analysis and comparison of treatments, Tukey's test, Bonferroni's test for critical difference among treatments.
7. Estimation of missing yields (upto two missing yields) in Randomised Block and Latin Square Designs, Efficiency of these designs.
8. Statistical Analysis of 2^2 and 2^3 factorial experiments

STA-312 Paper II (Part A)

(Based on STA 309 and STA 310)

HOUR PER WEEK	CREDIT	EXAM HRS
3	2.5	3

1. Construction of $\bar{X}$, R – chart,
2. Construction of $\bar{X}$ and S – chart, O.C. curve for $\bar{X}$ – chart.
3. Simple examples on $\bar{X}$, R and S charts,
4. Construction of p and np charts with fixed and floating sample sizes,
5. Construction of C, and U charts.
6. Acceptance Sampling: Single sampling Plan (for attributes). Drawing of O.C. curve, AOQ curve, ASN curve, ATI curve, problems based on AQL and LTPD
7. Simple problems based on acceptance sampling plans for variables.
8. Formulation of LPP and its solution using graphical method.
9. Simplex method (for 3 variables only)
10. Simplex Method and artificial variable (for 3 variables only)
11. Transportation problem – Initial Solution by North West corner rule, Row minima, column minima, matrix minima, Vogel's Approximation method
12. Optimum solution to the transportation problem using MODI method and assignment problem using Hungarian method.
13. Problems based on Sequencing.
14. Problems based on PERT and CPM.

STA-312 Paper II (Part B)

(Based on STA 309 and STA 310)

HOURS PER WEEK	***EXAM HRS***
3	***3***

Statistics Practical based on* STA 309 and STA 310 *using Microsoft Excel

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1. Construction of $\bar{X}$, R – chart,
2. Construction of $\bar{X}$ and S – chart, O.C. curve for $\bar{X}$ – chart.
3. Simple examples on $\bar{X}$, R and S charts,
4. Construction of p and np charts with fixed and floating sample sizes,
5. Construction of C, and U charts.
6. Acceptance Sampling: Single sampling Plan (for attributes). Drawing of O.C. curve, AOQ curve, ASN curve, ATI curve, problems based on AQL and LTPD
7. Simple problems based on acceptance sampling plans for variables.
8. Formulation of LPP and its solution using graphical method.
9. Simplex method (for 3 variables only)
10. Simplex Method and artificial variable (for 3 variables only)
11. Transportation problem – Initial Solution by North West corner rule, Row minima, column minima, matrix minima, Vogel's Approximation method
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