Post- Graduate Diploma in Statistical Methods with Applications

1. Scope

The course is intended to provide students with a comprehensive yet thorough training in basic theories, methods and applications of Statistics, in addition to some exposure to Mathematics and Computer Science. It is so designed that on successful completion, the students would be able to take up jobs as statisticians in such departments of government and industries where application of Statistics is limited, and also teach Statistics competently at + 2 level in schools as well as at undergraduate level in those courses where Statistics is taught at pass/minor level. The duration of this course is one year, and it will be offered at Tezpur, Assam, centre of the institute.

2. Eligibility

In order to be eligible for admission to this programme, a student must have a 3- year Bachelor's degree with Mathematics as one of the subjects at the undergraduate level. B.Tech. and B.E. degree holders are also eligible to apply. Any student who is asked to discontinue the programme, is not eligible for readmission into this programme.

3. Stipend and Book Grant

Each student admitted to this programme would receive a monthly stipend of Rs. 500/- (Rs. 2000 when revised) per month for a period of eleven months, and contingency book grant of amount Rs. 1000/- (Rs. 2000/- when revised) annually. Stipends would be granted, in the first instance, for the first semester only, and renewed if the progress of the student is found to be satisfactory. Stipends granted to a student may be reduced or fully withdrawn if the academic progress, attendance in class or character and conduct of the student are not found satisfactory.

4. Selection Procedure

Selection of candidates to this diploma course will be based on academic record and performance in written test(s) and interview. The selection test(s) will comprise objective and/or short-answer questions in Mathematics at pass/minor level of Bachelor's degree.

5. Course Structure and Syllabus

The one-year programme consists of a total of 10 courses distributed as five courses in each of the two semesters. While all the 5 courses in the first semester are compulsory, only 2 are so in the second semester. The remaining three *viz.*, *Special Topics I, Special Topics II, and Special Topics III* are module - based courses - each comprising 3 modules - to be chosen / offered out of a total of 17 modules on special topics. Each of these modules would be taught over a period of one month involving about 20 lecture hours.

Semester I Courses

(1) Real Analysis
(2) Linear Algebra
(3) Probability
(4) Descriptive Statistics
(5) Numerical Analysis and Programming in C

Semester II Courses

(6) Bivariate and Multivariate Analysis
(7) Statistical Inference
(8) Special Topics I [3 out of 17 modules to be offered]
(9) Special Topics II [3 out of the remaining 14 modules to be offered]
(10) Special Topics III [3 out of the last remaining 11 modules to be offered]

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SPECIAL TOPICS

(1) Time Series Analysis
(2) Econometrics
(3) Survival Analysis
(4) Clinical Trials
(5) Life Testing & Reliability
(6) Actuarial Methods
(7) Statistical Quality Control

(8) Operations Research
(9) Demography
(10) Sample Surveys
(11) Linear Models
(12) Design of Experiments
(13) Introduction to Stochastic Processes
(14) Statistical Computing
(15) Data Structures and Basic Algorithms
(16) Introduction to DBMS
(17) Topics of Current Interests

All students would be required to spend one week at the headquarters of the institute (Kolkata) at the end of Semester I. During this period, they would visit different units of the institute and also the NSSO, Kolkata

6. Examinations and Scores

Non -Module-Based Courses

The final (semestral) examination in a course is held at the end of the semester. Besides, there is a mid-semestral examination in each course. The calendar for the semester is announced in advance.
The composite score in a course is a weighted average of the scores in the mid-semestral and semestral examinations, homework, assignments, and /or project work in that course; the weights are announced beforehand by the Dean of Studies, or the In-Charge, Students' Academic Affairs or the Class Teacher, in consultation with the teacher concerned. **The minimum composite score to pass a course is 35%.**

Module-Based Courses

There will be one examination for each of the three modules for any modular-based course. Weightage to be given to homework, assignments etc. for any module would be decided by the concerned teacher, and announced beforehand. Equal weightage would be given to all the three modules for computing the composite score. **The minimum composite score to pass a course is 35%.**

Back- Paper Examination

For both types of courses, if the composite score of a student falls short of 45% in a course, the student may take a back-paper examination to improve the score. **At most one** back-paper examination is allowed in each course.

Moreover, a student can take at most **two** back-paper examinations in the first semester and **one** in the second semester. The decision to allow a student to appear for the back-paper examination is taken by the appropriate Teachers' Committee. The back-paper examination covers the entire syllabus of the course.

In case of back-paper examination in a module-based course, there would be one single question paper covering all the three modules with equal distribution of marks over the three modules. The total score obtained in a back-paper examination of any module-based course would be the total of marks obtained in the three modules.

When a student takes a back-paper examination in any of these two types of courses, his/her final score in that course is the higher of the back-paper score and the earlier composite score, subject to a maximum of 45%.

Compensatory Paper Examination

A student who gets less than 35% in at most one course even after the back-paper examination in *any* semester, but 60% or more in average in the other courses in that semester, is allowed to appear for a compensatory paper examination. In case of a module-based course, there would be one single question paper, like the back-paper examination, covering all the three modules with equal distribution of marks over the three modules. A student would be allowed to appear in at most one compensatory paper in every semester. Maximum marks obtainable in a compensatory paper would be 35%. In the second semester, a student would have to choose between the compensatory paper examination and the possibility of repeating the course. He/she would not be allowed to take both. A student would have to discontinue the course if he/she scores less than 35% in the compensatory paper in any semester.

Supplementary Examination

If a student misses the mid-semestral or semestral examination of a course or the examination for a module of a module-based course due to medical or family emergency, the Teachers' Committee may, on an adequately documented representation from the student, allow him/her to take a supplementary examination in the course for the missed examination.
The supplementary semestral examination for a non-module –based course is held at the same time as the back-paper examination for the semester and the student taking the supplementary semestral examination in a course is not allowed to take any further back paper examination in that course. For a module-based course, the supplementary examination is held at a convenient time. The maximum that a student can score in a supplementary examination is 60%. Unlike the back-paper examination, the score in the supplementary examination is used along with other scores to arrive at the composite score.

A student may take more than the allotted quota of back-paper examinations in a given academic year, and decide at the end of that academic year which of the back-paper examination scores should be disregarded.

7. Satisfactory Conduct

A student is also required to maintain satisfactory conduct as a necessary condition for taking semestral examination, for promotion and award of diploma. Unsatisfactory conduct will include copying in examination, rowdyism, other breach of discipline of the Institute, unlawful/unethical behaviour and the like. Violation of such nature is likely to attract punishments such as withholding promotion / award of diploma, withdrawing stipend and/or expulsion from the hostel / Institute.

Ragging is banned in the Institute and any one found indulging in ragging will be given punishment such as expulsion from the Institute, or suspension from the Institute/classes for a limited period and fine. The punishment may also take the shape of (i) withholding Stipend/Fellowship or other benefits,
(ii) withholding of results, (iii) suspension or expulsion from hostel and the likes. Local laws governing ragging are also applicable to the students of the Institute. Incidents of ragging may also be reported to the police.
The students are also required to abide by the following guidelines during the examinations:
(1)Students are required to take their seats according to the seating arrangement displayed. If any student takes a seat not allotted to him/her, he/she may be asked by the invigilator to hand over the answer script (i.e., discontinue the examination) and leave the examination hall.
(ii)Students are not allowed to carry inside the examination hall any mobile phone with them–even in switched-off mode. Calculators, books and notes will be allowed inside the examination hall only if these are so allowed by the teacher(s) concerned (i.e., the teacher(s) of the course), or if the question paper is an open-note/open-book one. Even in such cases, these articles cannot be shared.
(iii)No student is allowed to leave the examination hall without permission from the invigilator(s).
Further, students cannot leave the examination hall during the first 30 minutes of any examination.

Under no circumstances, two or more students writing the same paper can go outside together.
(iv)Students should ensure that the main answer booklet and any extra loose sheet bear the signature of the invigilator with date. Any discrepancy should be brought to the notice of the invigilator immediately. Presence of any unsigned or undated sheet in the answer script will render it (i.e., the unsigned or undated sheet) to be cancelled, and this may lead to charges of violation of the examination rules.
(v)Any student caught cheating or violating examination rules will get ‘Zero’ in that examination. If the offence is in a back-paper examination, the student will get ‘Zero’ in the back-paper. (The other conditions for promotion, as mentioned in Section 8 below, will continue to hold).

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Failing to follow the examination guidelines, copying in the examination, rowdyism or some other breach of discipline or unlawful/unethical behaviour etc. are regarded as unsatisfactory conduct.

The decisions regarding promotion in Section 8 and final result in Section 9 are arrived at taking the violation, if any, of the satisfactory conduct by the student, as described in this section.

8. Promotion

A student is considered for promotion to the second semester of the programme only when his/her conduct has been satisfactory. Subject to the above condition, a student is promoted from first semester to second semester if

(i) the number of composite scores less than 45% is at most **two** ,and
(ii) **no** composite score in a course is less than 35%.

Otherwise, a student is **not promoted** to the second semester and he/she is asked to discontinue the programme.

9. Final Result

At the end of the second semester, the overall average of the percentage composite scores in *all the courses taken in the two-semester* programme is computed for each student. The student is awarded the post-graduate diploma in one of the following categories according to the criteria he/she satisfies provided, in the second semester, (i) he/she **does not have** a composite score of less than 35% in any course, (ii) the number of scores less than 45% is at most **one**, and (iii) his/her conduct is satisfactory.

Post-Graduate Diploma in Statistical Methods with Applications : passed in First Division with Distinction if
(i) the overall average score is at least 75%, and
(ii) the composite score in at most **one** course is less than 45%.

Post-Graduate Diploma in Statistical Methods with Applications : passed with First Division if
(i) the overall average score is at least 60%,
(ii) the composite score in at most **one** course is less than 45%, and
(iii) not obtained First Division with Distinction.

Post-Graduate Diploma in Statistical Methods with Applications : passed with Second *Division* if
(i) the overall average score is at least 45%,
(ii) the composite score in at most **two** courses is less than 45%, and
(iii) not obtained First Division with Distinction or First Division.

All others students are considered to have failed. A student who fails but obtains at least 35% average score in the second semester, and have satisfactory conduct is allowed to repeat the programme without any stipend all throughout the year **provided that he/she has not taken the option of a compensatory paper examination in the second semester**. A student is not given more than one chance to repeat.

10. Award of Certificate

A student passing the Diploma is given a certificate which includes (i) the list of all courses taken along with the respective composite scores, and (ii) the category (Passed with Distinction or Passed) of his/her final result.
The certificate is awarded in the Annual Convocation of the Institute following the last semestral examinations.

11. Prizes and Medals

Students are awarded prizes in form of book awards for good academic performances in each semester as decided by the Teachers' Committee.

12. Class-Teacher

One of the instructors of a class is designated as the Class Teacher. Students are required to meet their respective Class Teachers periodically to get their academic performance reviewed, and to discuss their problems regarding courses.

13. Attendance

Every student is expected to attend all the classes. If he/she is absent, he/she must apply for leave to the Dean of Studies or the Academic Coordinator. Failing to do so may result in disciplinary action.

14. Stipend

Stipend, if awarded at the time of admission, is valid initially for the first semester only. The amount of stipend to be awarded in the second semester will depend on academic performance and conduct, as specified below, provided the requirements for continuation of the academic programme (excluding repetition) are satisfied.

Performance in course work:
All composite scores used in the following are considered after the respective back-paper examinations.

(i)If all the requirements for continuation of the programme are satisfied, and the average composite score is at least 60% and the number of courses with scores less than 45% is at most **two** in the first semester, then the full value of the stipend is awarded in the second semester.
(ii)If all the requirements for continuation of the programme are satisfied, and the average composite score is at least 45% and the number of courses with scores less than 45% is at most **one** in the first semester, then the half value of the stipend is awarded in the second semester.
(iii)In all cases other than(i) and(ii) above, no stipend is awarded in the second semester.

Attendance:
(ii)If the overall attendance in all courses in the first semester is less than 75%, no stipend is awarded in the following semester.

Conduct:
(i)The Dean of Studies, or the In-Charge, Students'Academic Affairs or the Class Teacher, at any time, in consultation with the respective Teachers' Committee, may withdraw the stipend of a student fully for a specific period if his/her conduct in the campus is found to be unsatisfactory.
Note: The net amount of the stipend to be awarded is determined by simultaneous and concurrent application of all clauses described above; but, in no case, the amount of stipend to be awarded or to be withdrawn should exceed 100% of the prescribed amount of stipend.
Stipends are given after the end of each month for eleven months in each academic year. The first stipend is given two months after admission with retrospective effect provided the student continues in the Diploma programme for at least two months.
Contingency grants can be used for purchasing a scientific calculator and other required accessories for the practical class, text books and supplementary text books and for getting photostat copies of required
academic material. All such expenditure should be approved by the Class Teacher. No contingency grants are given in the first two months after admission.

15. Library Rules

Each student is allowed to use the reading room facilities in the library and allowed access to the stacks. Students have to pay a security deposit of Rs. 250 in order to avail himself/herself of the borrowing facility. A student can borrow at most four books at a time.
Fine is charged if any book is not returned by the due date stamped on the issue-slip. The library rules, and other details are posted in the library.

Tentative Syllabi for the courses

SEMESTER I

Real Analysis

Sets and functions, countable and uncountable sets. Real numbers-field properties and completeness of real numbers (axiomatic approach), properties least upper bound and greatest lower bounds. Sequences-limit points of sequence, convergent sequences, bounded and monotone sequences, the limit superior and limit inferior of a sequence. Cauchy sequence. Series- convergence and divergence of series, absolute and conditional convergence. Test of convergence. Continuous and differentiable functions. Rolle's theorem and mean value theorem. Local maxima and local minima. Taylor's theorem. Definition of Riemann Integral, fundamental theorem. Function of several variables. The notion of total derivative as a linear map, notion of Jacobian. Partial derivatives, directional derivatives. Chain rule. Lagrange multiplier. Introduction to multiple integrals, computation of Jacobian, change of variable formula. Integrals as functions of parameter(s) and differentiation under integration.

References:

1. Principles of Real Analysis - Rudin, W.
2. Mathematical Analysis – Apostol
3. Introduction to Calculus and Analysis (Volumes I & II) – Courant, R. and F. John.

Linear Algebra

Matrices and determinants. System of linear equations, matrix representation of a linear system. Vector spaces and related concepts, subspaces. Bases and dimension. Homomorphisms and isomorphisms of vector spaces. Rank and nullity of a linear mapping. Nonsingular mappings. Matrix representation of a linear mapping. Elementary matrices. Rank of a matrix. Block multiplication of matrices. Row equivalence. Change of basis. Equivalence and similarity. Eigen values and eigen vectors. **Idempotent matrices.** Characteristic polynomial and minimal polynomial. Jordon canonical form. Reduction to Jordon form. Cayley-Hamilton theorem. Bilinear forms. Quadratic forms and related concepts. **Canonical representation of a quadratic form.** Computations.

References:

1. Linear Algebra - Rao, A.R. & P. Bhimasankaram
2. Linear Algebra – Hoffman , K. and R. Kunze
3. Introduction to Linear Algebra – Mirsky L.

Probability

Elementary concepts: experiments, outcomes, sample space, events. Discrete sample spaces and probability models. Combinatorial probability, Fluctuations in coin tossing and random walks, Combination of events. Conditional probability, Bayes theorem, independence. Discrete random variables. Standard discrete distributions. Expectation/mean, variance, moments, moment generating functions, probability generating functions. Univariate continuous distributions, CDFs and properties, Examples of standard densities. Normal distribution and properties. Expectation/mean of a continuous random variable, variance, moments. Moment generating function. Distribution of a function of a random variable.

References:

Goon-Gupta-Dasgupta……Fundamentals of Statistics – Vol. I
N. L. John and S. Kotz …..Discrete & Continuous Distributions. Wiley
Sheldon Ross A First Course in Probability
Jim Pitman Probability

Descriptive Statistics

Different types of statistical problems and related data analysis (emphasis should be on concrete examples and real scientific investigations where statistics is relevant, including applications of discrete, continuous and categorical data). Collection and summarization of univariate and bivariate data including graphical methods. Measures of location, spread, skewness, kurtosis; measures of association; various properties of these measures and their utility (illustration with specific examples and numerical exercises, possibly using statistical packages). Concept of sample versus population. Brief history of evolution of Statistics; Use of statistical packages.

References:

Fundamentals of Statistics….Vol. I by Goon-Gupta-Dasgupta

Statistics: A Guide to the Unknown by J.M. Tanur (ed.).
Statistics by D. Freedman, R. Pisani and R. Purves.
An Investigation for a Course in Statistics by *M. Tanner*.
Mathematics of Statistics by J.F. Kenney and E.S. Keeping.
Applied General Statistics by F.E. Croxton and D.J. Cowden.
Statistics: A New Approach by W.A. Wallis and H.V. Roberts.

Numerical Analysis and Programming in C

Numerical Analysis

Significant digits, round-off errors. Finite computational processes and computational errors. Floating point arithmetic and propagation of errors. Loss of significant digits.

Interpolation with one variable: finite differences, divided differences. Lagrangian and Newtonian methods. Iterative methods. Errors and remainder terms. Inverse interpolation. Interpolation with two variables.

Numerical integration: Newton-Cotes; Orthogonal polynomials and Gaussian quadrature. Accuracy of quadrature formulae.

Numerical differentiation: Numerical solution of ordinary differential equations: one step and multistep methods. Euler's, Adam's, Runge-Kutta's methods. Predictor-corrector methods.

Numerical solution of nonlinear equation in one variable.

Separation of roots and initial approximation. Sturm's theorem. Improvement of the initial solution using methods of bisection, Regula Falsi and Newton-Raphson. Fixed point iterative schemes. Errors. Order of convergence and degree of precision.

Numerical solution of system of linear equations and matrix inversion: Gaussian elimination, square root, L-U methods.

Programming in C Constants,variables,
data-types. Operators: arithmetic,
relational, logical.
Assignments,increment/decrement, operators.
Decision- making and branching.
Creation of loops: for loop, while loop, and do-while loop.

Character manipulations: reading strings from terminal, writing strings to the screen, formatted input and formatted output.
1D and 2D arrays.
Introduction to pointers.
Functions; parameter passing.

Structure definition ,and use of structure variables.
Files: input/output operations.

References:

1. B. W. Keninghan & Dennis M. Ritchie: The C Programming Language.
2. S.D. Conte and C. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.
3. D.K. Faddeev and V.H. Faddeeva: Computational Methods in Linear Algebra.
4. B.C.Gottfried: Schaum's Outline of Programmng with C, McGraw-Hill, 1996.

SEMESTER II

Bivariate and Multivariate Analysis

Plots of bivariate data.
Correlation, regression and linear regression models.
Study of outliers.
Bivariate and multivariate normal distributions with inference.
Bivariate continuous distributions, conditional and marginal distributions.
Discriminant and Cluster analysis ; Principal component analysis.
Use of appropriate statistical softwares.

References:

Fundamentals of Statistics….Vol. I by Goon-Gupta-Dasgupta
Linear Models: An Integrated Approach by D. Sengupta and S.R. Jammalamadaka.

Regression Analysis by Examples by S Chatterjee & G Hadi

Statistical Inference

Problems of statistical inference – Estimation and Tests of Hypotheses. Methods of estimation with illustrative examples based on data from standard discrete and continuous distributions. Notion of statistics and estimators, sampling distribution and standard error of a statistic. Properties of estimators. Unbiased and biased estimators, Concept of mean squared error and variance. Minimum variance unbiased estimators. Cramer-Rao bound. Notions of null and alternative hypotheses, Level of significance of a test, size and power. Large sample tests and confidence intervals for means and proportions in one- and two-sample problems.

References

Mathematical Statistics by P.J. Bickel and K.A. Doksum.

Statistical Inference by G. Casella and R.L. Berger.

Linear Statistical Inference and its Applications by C.R. Rao.

Theory of Point Estimation by E.L. Lehmann.

Testing Statistical Hypotheses by E.L. Lehmann.

Nonparametrics: Statistical Methods Based on Ranks by E.L. Lehmann.

- *Fundamentals of Statistics, Vol. I by Goon-Gupta-Dasgupta*
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Syllabi of Special Topics (i.e., module-based courses - about 20 lecture hours each)

Time Series Analysis

1. Exploratory Analysis of Time Series: Graphical display, classical decomposition model – trend, seasonal and cyclical components.
2. Stationary Stochastic Time Series: Weak and strong stationarity; AR, MA and ARMA models; Box-Jenkin's correlogram analysis – ACF and PACF; diagnostic tests.
3. Non-Stationary Time Series: ARIMA model; deterministic and stochastic trends; unit root tests – DF and ADF tests.
4. Forecasting based on ARIMA/ARMA model.
5. Introductory VAR Analysis.

References:

(i) Brockwell, P. and R.A. Davis (2002): Introduction to Time Series and Forecasting, 2nd edition, Springer-Verlag.

(ii) Chatfield, C. (1996): Analysis of Time Series, 5th edition, Chapman & Hall.

(iii) Mills, T.C. (1990): Time Series Techniques for Economists, Cambridge University Press.

(iv) Mills, T.C. (1999): The Econometric Modelling of Financial Time Series, 2nd edition, Cambridge University Press.

Econometrics

(1) Classical Linear Regression Model: Assumptions; OLS method of estimation; tests of hypotheses; use of dummy variables in regression.

(2) Problems of Heteroscedasticity and Autocorrelation: GLS method of estimation; tests for heteroscedasticity and autocorrelation.

(3) Multicollinearity: Nature of the problem and its consequences; econometric solutions.
(4) Introductory Analysis of Panel Data.

References:

(i) Brooks Chris (2002): Introductory Econometrics for Finance, Cambridge University Press.
(ii) Johnston, J. and J. DiNardo (1997): Econometrics Methods, 4th edition, McGraw-Hill.
(iii) Kmenta, J. (1990): Elements of Econometrics, 2nd edition, Macmillan.
(iv) Maddala, G.S.(2001): Introduction to Econometrics, John Wiley.

Survival Analysis

Survival data, hazard function (continuous and discrete).
Nonparametric inference: Kaplan-Meier estimate, Nelson-Aalen estimate.
Comparison of survival curves – log-rank test.
Survival models: Exponential, Weibull, log-normal, gamma, etc., Cox's proportional hazards model.
Parametric inference: Censoring mechanisms and likelihood, large-sample likelihood theory, iterative methods for solution.
Partial likelihood for Cox's model, estimation of survival functions.
Survival data with competing risks.

References:

Lawless JF (2003). Statistical Models and Methods for Lifetime Data, John Wiley, 2nd Ed.
Kalbfleisch and Prentice (1980): Analysis of Failure Time Data
Klein and Moeschberger : Survival Analysis

Clinical Trials

Different phases, comparative and controlled trials, random allocation,
parallel group designs, crossover designs, symmetric designs, adaptive designs, group sequential designs, Zelen's designs, selection of subjects, ethical issues, outcome measures, protocols, sample size determination, etc.

Refrerences:

S Pocock. Clinical Trials: A Practical Approach
Whitehead J (1997). The Design and Analysis of Sequential Clinical Trials, Wiley, Chichester, England.

Life Testing and Reliability

Different life-time distributions and their properties, mean time Between failures, hazard rates, different failure models and the test for their validity, problems of inference (estimation and testing) for the parameters of common life-time distributions, estimation from uncensored and censored samples, concepts of accelerated life testing. Fault tree analysis, coherent systems, basic concepts of component and system reliability, reliability bounds, nonparametric classes of life-time distributions.
Maintained systems and system availability.

References:

Barlow and Proschan: Life Testing and Reliability

Actuarial Methods

Review of decision theory and actuarial applications. Loss distributions, modelling of individual and aggregate losses, moments, fitting distributions to claims data, deductibles and retention limits, proportional and excess-of-loss reinsurance, share of claim amounts, parametric estimation with incomplete information. Risk models: models for claim number and claim amount in short-term contracts, moments, compound distributions, moments of insurer's and reinsurer's share of aggregate claims. Experience rating: rating methods in insurance and banking, claim probability calculation, stationary distribution of proportion of policyholders in various levels of discount. Delay/run-off triangle: development factor, basic and inflation-adjusted chain-ladder method.

References:

Boland PJ (2007). Statistical and Probabilistic Methods in Actuarial Science, CRC Press.
Klugman, Panjer and Wilmot (2004). Loss Models.

Statistical Quality Control

Concept, measurement and control of quality. Seven tools of Quality Control. Control charts – Concepts of control charts, *-R, p, np,* and *c* charts. Interpretation of control charts.
Acceptance sampling – inspection by attributes, OC curve, producer's and consumer's risks, AQL, LTPD, AOI, AOQL, IQL, single and double sampling plans.

References

• *Introduction to Statistical Quality Control* by D.C. Montgomery.

- *Principles of Quality Control* by Jerry Banks.
- *Quality Control and Industrial Statistics* by A.J. Duncan.
- *Process Quality Control* by E.Q. Ott.

Operations Research

Nature of OR problems and applications in different areas. The LP problem, its formulation, graphic solution of two variable problems. Transportation and assignment problems. Deterministic inventory models – ABC analysis and inventory management. Queuing theory – single server waiting time model.

References

- *Operations Research - An Introduction by H.A. Taha.*
- *Principles of Operations Research by H M Wagner.*
- *Operations Research by F.S. Hiller and G.J. Liberman*.

Demography

Scope and importance of demography. Data sources and their limitations. Population census, Vital registration, Population register, Demographic and Health surveys, other sources. Evaluation and adjustment of census and survey data on age-sex distribution.
Growth of Human Population: Rate of natural increase; Arithmetic, Geometric and Exponential growths.
International statistical classification of diseases, injuries and causes of death. Measures based on diseases (i.e., morbidity), death (i.e, mortality) and birth (i.e., fertility) statistics including measures such as Gross and Net reproduction rates, Mean length of generation, and Census measures of fertility.
Life Tables: definition, simple construction and applications.
Concept of Migration.

References

- *Technical Demography by R. Ramkumar.*
- *Demographic Techniques and Applications by K. Srinivasan.*
- *An Introduction to the Study of Population by B.D. Mishra.*
- *The Methods and Materials in Demography by H.S. Shryock.*

Sample Surveys

Basic sampling techniques. Methods of sampling – equal probability (SRS) sampling with and without replacement, Stratified random sampling, systematic sampling, cluster sampling. Estimation of total/average/proportion for population or domain; Computation of standard error. Ratio and regression estimators.

References:

- *Sampling Techniques by W.G. Cochran.*
- *Sampling Theory and Methods by M.N. Murthy.*
- *Theory and Methods of Survey Sampling by P. Mukhopadhyay.*

Linear Models

Concept of a linear model (with illustrative examples), parameters, parametric functions, errors and their properties, notion of unbiased estimation of parameters and parametric functions, estimators and error functions, best linear unbiased estimators, Gauss-Markov linear model, estimation and error space, tests of hypotheses, elementary statistical inference, one and two-way anova models, regression models

References:

- *Linear Models by S.R. Searle.*
- *An introduction to Linear Statistical Models, Vol. I* by F.A. Graybill.
- *Linear Statistical Models by J.H. Stapleton.*
- *Methods and Applications of Linear Models by R.R. Hocking.*
- *Linear Models: An Integrated Approach by D. Sengupta and S.R. Jammalamadaka.*
- *Linear models & Design of Experiments by D D Joshi*

- *Linear statistical inference and its applications by C R Rao*

Design of Experiments

Basic principles of DoE : Randomization, replication and local control, CRD, RBD and Latin Square Designs and their analyses. Notions of factorial experiments, main effects and their interactions, analysis of 2^n factorial experiments w

ith / without replications (special cases of n = 2, 3, 4, 5). Notions of blocking, confounding and balance. Balanced confounded 2^n factorial experiments in 'k' blocks with n = 3, 4, 5 and with suitable values of 'k'.

References:

Design and Analysis of Experiments by A. Dean and D. Voss

Design and Analysis of Experiments by D.C. Montgomery.

Experimental Designs by W.G. Cochran and G.M. Cox.

The Design and Analysis of Experiments by O. Kempthorne.

Theory of Block Designs by A. Dey.

Linear Models & Design of Experiments by D D Joshi

Introduction to Stochastic Processes

Discrete Markov chains: Definition, transition probability matrices, first step analysis, classifications, limiting behaviour, recurrence and transience; Applications: random walk and gambler's ruin problem; birth and death chains, branching chains, queuing chains, etc.

References:

(1) An Introduction to Stochastic Modelling by H.M. Taylor and S. Karlin.
(2) Introduction to Stochastic Processes by P.G. Hoel, S.C. Port, C.J. Stone.
(3) Stochastic Processes by S.M. Ross.
(4) Introduction to the Theory of Probability and its Applications (Vol. 1) by W. Feller.

Statistical Computing

- Review of simulation techniques for various probability models
- Different resampling plans.
- Nonlinear regression and generalized linear models with applications
- Cluster analysis and other multivariate applications
- Smoothing and function estimation
- EM algorithm, single and multiple imputation
- Markov Chain Monte Carlo techniques.

References:

Gentle JE (1998). Random Number Generation and Monte Carlo Methods, Spriner-Verlag, New York.

Robert CP and Casella G (1999). Monte Carlo Statistical Methods, Springer-Verlag, New York.

J. E. Gentle, W. Härdle and Y. Mori: Handbook of Computational Statistics Concepts and Methods.

Good PI (1999). Resampling Methods: A Practical Guide to Data Analysis, Birkhauser, Boston.

Davison and Hinkley (1997). Bootstrap Methods and their Application, Camb. Univ. Press, Cambridge.

P McCullagh and JA Nelder (1989). Generalized Linear Models, 2nd Ed, Chapman and Hall.

Data Structures and Basic Algorithms

Review of pointers.
Dynamic memory allocation.
Definitions, operations, implementations and applications of basic data structures.
Array, linked lists, stack, queue.
Binary tree : traversal algorithms, heap, binary search tree, AVL tree.
Binary tree: insertion,deletion and search of a node.
Hashing techniques.
Finding maximum and minimum.
Linear and binary search.
Sorting: Bubble, Selection, Quick, Merge and Heap sort.

References:

1. Brian W. Kernighan and Dennis M. Ritchie: The C Programming Language.
2. R.L. Kruse:Data Structures and Program design in C, PHI,1996.
3. A. Aho, J. Hopcroft and J. Ullman: Data Structures and Algorithms, Addison-Wesley, 1983.
4. E.Horowitz and S.Sahni: Fundamentals of Data Structures.
5. T.H.Cormen, C.E.Leiserson and R.L.Rivest: Introduction to Algorithms.

Introduction to DBMS

Entity-relationship model; Rational model; Rational algebra; Structured query.
Language: Description of an actual RDBMS and SQL; Normalization; Mini project.

References:

A.Silberschatz, H.F. Korth and S. Sudarshan: Database System Concepts, McGraw- Hill

Topics of Current Interests

All the course instructors should be encouraged to accommodate small projects.