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UNIVERSITY OF MYSORE

Estd. 1916

Vishwavidyanilaya Karyasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/31/18-19

Dated: 15.06.2018

NOTIFICATION

Sub: Revision of syllabus for Statistics (UG) as per CBCS pattern from the academic year 2018-19.

Ref: 1. Decision of Board of Studies in Statistics (CB) meeting held on 04.12.2017.
2. Decision of the Faculty of Science & Technology Meeting held on 21.04.2018.
3. Decision of the Deans Committee meeting held on 22.05.2018.

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The Board of Studies in Statistics (CB) which met on 04th December, 2017 has recommended to revise the syllabus for B.Sc. Statistics as per CBCS pattern from the academic year 2018-19.

The Faculty of Science and Technology and the Deans committee meetings held on 21-04-2018 and 22-05-2018 respectively have approved the above said proposal with pending ratification of Academic Council and the same is hereby notified.

The CBCS syllabus of B.Sc. Statistics course is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

15/6

Deputy Registrar(Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, Manasagangotri, Mysore.
3. The Chairperson, BOS in Statistics, DOS in Statistics, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Statistics, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Principals of the Affiliated Colleges where UG Program is running in Science stream.
7. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
9. Office file.

SCHEME of INSTRUCTION and **SYLLABI**

for proposed **B.Sc. with STATISTICS as ONE OPTIONAL** under

CHOICE BASED CREDIT SYSTEM (CBCS) and

CONTINUOUS ASSESSMENT AND GRADING PATTERN (CAGP)

1. Scheme of Admission: Based on Merit-cum-Roster system of the University of Mysore and Govt. of Karnataka.
2. Eligibility: PUC or +2 or equivalent with Statistics or Mathematics as one of the subjects under Science stream. Commerce stream students are not eligible for admission to B.Sc. with Statistics as one optional.
3. Teaching Schedule: 4 hours per week for a Theory paper of 4 credits, 2 hours per week for Practical paper of 1 credit.
4. Scheme of Examination:
   (i) Theory paper of 4 credits - 03 hours : 80 marks
   (ii) Theory Internal Assessment : 20 marks
   Test 1: 10 marks
   Test 2: 10 marks
   (iii) Practical of 2 credits of 03 hours: 40 marks
   Practicals Internal Assessment : 10 marks
   Test 1: 05 marks
   Test 2: 05 marks
5. Pattern of Question Paper:

(i) For the two theory internal assessment tests, students shall answer any 4 questions out of 6 questions, each carrying 5 marks, totalling a maximum of 20 marks, and marks scored by a student out of 20 shall then be reduced to 10 marks.

(ii) For the final examination of theory paper for 80 marks, students shall answer any 5 questions out of 8 questions a to h in Part A, each question carrying 3 marks for a maximum of 15 marks and students shall answer any 5 questions out of 8 questions with numbers 2 to 9 in Part B, each question carrying 13 marks for a maximum of 65 and each question having two or three subquestions with the marks split as 3+4+6 or 4+4+5.

(iii) For other theory papers with less credits, the questions and marks are proportionally reduced.

(iv) For the two practical internal assessment tests, students shall answer any 4 questions out of 6 questions, each carrying 5 marks, totalling a maximum of 20 marks, and marks scored by a student out of 20 shall then be reduced to 5 marks.

(v) For the final examination of practical paper for 40 marks, students shall answer any 3 questions out of 5 questions, each question carrying 13 or 14 marks for a maximum of 13+13+14 = 40 marks.

(vi) For other practical papers with less / more credits, the questions and marks are proportionally enhanced / reduced.

8. A particular Elective will be offered depending upon the availability of qualified teachers.

B.Sc. with STATISTICS as a MAJOR / OPTIONAL Paper

SYLLABI for Semester I to VI

First Semester

Discipline Specific Course (DSC):

Paper 1: Descriptive Statistics-1 and Basic Probability (4 Credits – 4 hours of Theory teaching teaching per week)

Unit 1: Concept of statistical population and sample. Types of data: Discrete, Continuous, Frequency and non-grouped data, nominal, ordinal, interval, ratio, time series data, Primary data (designing a questionnaire schedule), Secondary data (major sources including some government publications). Construction of frequency tables (with one or more factors), diagrammatic and graphical representation of grouped data, frequency and cumulative frequency distributions and their applications, Histogram, frequency curve, ogives, stem-and-leaf plots, box-plots. ...**12L**

Unit 2: Concept of central tendency (CT), various measures of CT and their merits, demerits, properties and applications, Partition values. Concept of variation/dispersion, absolute and relative measures, their merits, demerits and applications. Moments, Skewness, Kurtosis and their measures. ... **12L**

Unit 3: Random experiment: Trial, sample point, sample space, definitions of equally likely, mutually exclusive and exhaustive events, definition of probability, classical and relative frequency approach to probability, axiomatic approach to probability and its properties. Conditional probability, independence of events, total probability, Bayes' theorem and its applications. **…12L**

Unit 4: Discrete random variable, probability mass function (pmf), distribution function, illustrations. Expectation of random variable and its properties, moments, measures of location, variation, skewness, kurtosis; moments in terms of expectation, moment generating function of a random variable, their properties and uses. Standard discrete distributions and their properties including degenerate, discrete uniform, Bernoulli, Binomial, Poisson, Geometric, Negative binomial, Hypergeometric distributions. ...**12L**

Books for reference:

1. Agarwal, B. L. (2006): Basic Statistics, New age International (P) Ltd
2. Bhat B.R., Srivenkataramana T. and Rao, Madhava K.S. (1996): Statistics, A Beginner's Text, Vol. I and II, New Age International (P) Ltd.
3. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
4. Hogg, R.V. and Craig, A.T. (1972): Introduction to Mathematical Statistics, Amerind Publishing Co.
5. Gupta, S.C., and Kapoor, V.K. (2014): Fundamentals of Mathematical Statistics, Sultan Chand publications.

5. Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
7. Rohatgi V.K. and Md. Ehsanes Salah, A.K. (2001): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
8. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
9. Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
10. Medhi, J. (1992): Statistical Methods - an introductory text, New Age Intl. Publications.

Discipline Specific Course (DSC):

Paper 2: Practical – 1 (2 Credits – 4 hours of Practical teaching per week)

Practicals: (About 30 in number)

1. Presentation of data by frequency tables, diagrams and graphs, stem and leaf, Box plot partition values.
2. Arithmetic Mean (AM), geometric mean, harmonic mean, weighted AM, trimmed mean, corrected mean.
3. Mode, median, partition values.
4. Absolute and relative measures of dispersion.
5. Problems on moments, skewness and kurtosis.
6. Computing probability: using addition and multiplication theorems.
7. Conditional probability and Bayes' theorem.
8. Problems on pmf, expectation, variance, quantiles, skewness, kurtosis.
9. Sketching distribution functions. Computation of probabilities and fitting of discrete distributions.
10. Simulation from discrete distributions.

Second Semester

Discipline Specific Course (DSC):

Paper 3: Descriptive Statistics-2 and Probability distributions – 1 (4 Credits – 4 hours of Theory teaching per week)

Unit 1: Bivariate data: plotting of bivariate data, Principle of least squares, fitting of linear, parabolic, exponential and geometric curves. Scatter diagram, Product moment correlation coefficient and its properties, coefficient of determination, rank correlation, correlation ratio, interclass correlation .Concept of error in regression, fitting of linear regression and related results. **...12L**

Unit 2: Partial correlation, multiple correlation and regression in three variables, their measures and related results. Independence and Association of attributes, various measures of association for two way and three way classified data. **…12L**

Unit 3: Continuous random variables, probability density function, illustrations of random variables and their properties, expectation of a random variable and its properties - moments and quantiles. Moment generating functions, their properties and uses. Standard univariate continuous distributions and their properties, uniform, exponential, Normal, beta, gamma, Cauchy, Laplace, Logistic, Pareto, Log-normal distributions and their properties. **...12L**

Unit 4: Bivariate discrete and continuous distribution, its pmf / pdf; marginal and conditional distributions. Bivariate moments: Definition of raw and central product moments, conditional mean and conditional variance, covariance, correlation. Trinomial distribution and bivariate normal distribution and their properties. **...12L**

Books for reference:

1. Bhat, B.R., Srivenkataramana, T. and Rao, Madhava K.S. (1996): Statistics, A Beginner's Text, Vol. I and II, New Age International (P) Ltd.
2. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Hogg, R.V, McKean, J. W and Craig, A.T. (2013): Introduction to Mathematical Statistics, Seventh edition, Pearson.
4. Gupta, S.C., and Kapoor, V.K. (2014):Fundamentals of Mathematical Statistics, Sultan Chand publications.
5. Mood, A.M., Greybill, F.A. and Bose, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
7. Rohatgi V.K. and Md. Ehsanes Salah, A.K. (2001): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
8. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
9. Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
10. Medhi, J. (1992): Statistical Methods - an introductory text, New Age Intl. Publications.

Discipline Specific Course (DSC):

Paper 4: Practical – 2 (2 Credits – 4 hours of Practical teaching per week)

Practicals: (About 30 in number)

1. Fitting of curves by least squares method.
2. Product moment correlation coefficient.
3. Rank correlation.
4. Regression of two variables.
5. Partial and Multiple correlation and regression.

6. Problems on Association of attributes.
7. Sketching distribution and density functions.
8. Computation of Expectation, moments and Moment generating functions.
9. Simulation of random samples from standard univariate continuous distributions such as Normal, exponential.
10. Fitting of standard univariate distributions such as Normal, exponential.
11. Computing marginal and conditional Probability distributions.
12. Computing marginal and conditional expectations.
13. Drawing random samples from bivariate Normal distribution.

Third semester

Discipline Specific Course (DSC):

Paper 5: Probability distributions – 2, Limit Theorems and Estimation (4 Credits – 4 hours of Theory teaching per week)

Unit 1: Functions of random variables and their distributions using Jacobian and other tools (univariate and bivariate case). Concepts of population, parameter, random sample from a distribution, statistic and its sampling distribution, standard error of an estimate, standard errors of sample mean and proportion, derivation of Chi-square, t distributions and their properties. F distribution and its properties. Distributions of sample mean and sample variance and independence of sample mean and variance in random sampling from a normal distribution. **..16L**

Unit 2: Limit theorems: Chebychev's inequality, proof and applications and Markov's inequality. Concepts of convergence in distribution and convergence in probability. Weak law of large numbers (statement only) with applications. Central limit theorem - De Moivre - Laplace and Levy - Lindberg theorems (statements and applications). **… 08L**

Unit 3: Point estimation: Estimator and estimate. Properties of estimators - unbiasedness, relative efficiency and consistency. Methods of estimation - method of moments and method of maximum likelihood and their properties. **...12L**

Unit 4: Interval estimation - confidence intervals for Means, difference between means, proportions, difference between proportions, variance and ratio of two variances. Variance and ratio of variances of two independent Normal distributions, large sample confidence interval for proportions. **...12L**

Books for Reference:

1. Hogg, R.V, McKean, J. W and Craig, A.T. (2013): Introduction to Mathematical Statistics, Seventh edition, Pearson.
2. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
3. Rohatgi V.K. and Md. Ehsanes Salah, A.K. (2001): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
4. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.

5. Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.
6. Gupta, S.C., and Kapoor, V.K. Fundamentals of Mathematical Statistics, Sultan Chand publications.
7. Hoel, P.G. (1971): Introduction to Mathematical Statistics, Asia Publishing House.
8. Meyer, P.L. (1970): Introductory Probability and Statistical Applications, Addison Wesley.

Discipline Specific Course (DSC):

Paper 6: Practical – 3 (2 Credits – 4 hours of Practical teaching per week)

Practicals: (About 30 in number)

1. Sketching distribution and density functions.
2. Computation marginals, joint distribution functions, mean, variance.
3. Estimation by consistency and relative efficiency.
4. Estimation by the method of moments and method of maximum likelihood.
5. Construction of confidence intervals.
6. Problems on Chebychev's and Markov's inequalities.
7. Applications of convergence in distribution, convergence in probability, Weak law of large numbers and Central limit theorem.

Fourth Semester

Discipline Specific Course (DSC):

Paper 7: Testing of Hypotheses and Design of Experiments (4 Credits – 4 hours of Theory teaching per week)

Unit 1: Statistical Tests: Null and alternative hypotheses, Types of error, level of significance, power of a test, critical region, critical function, randomized and non randomized test, p- values, N-P lemma (statement only), Most powerful test, UMP test, Monotone likelihood ratio (MLR) property, statement of the theorem on UMP test for testing one sided hypothesis for the distribution with MLR property. Likelihood ratio tests for testing for the mean and variance of univariate normal distribution, testing for equality of two means and testing for equality of variances of two univariate normal distributions. Testing for the significance of correlation coefficient. **...14L**

Unit 2: Use of central limit theorem for testing a single mean, single proportion, equality of two means and two proportions, Fisher's Z transformation and its uses, Pearson's chi-square test for goodness of fit, test of independence of two attributes. Nonparametric tests: concept of a non-parametric tests, Sign test for one sample, Wilcoxon signed rank test, Kolmogorov-Smirnoff one sample test, Wilcoxon-Mann-Whitney test, Run test, median test, and Spearman’s rank

correlation test (large sample approximations only). Kruskal-Wallis K Sample Test. QQ plot for some simple tests. **...10L**

Unit 3: Gauss Markov model and Gauss-Markov theorem (statement only), Analysis of variance (fixed effects only), Analysis of one-way and two-way classified data. Need for design of experiments, fundamental principle of design of experiments, basic designs: CRD, RBD and LSD and least squares estimators of parameters, hypothesis and test procedure and ANOVA table. **…12L**

Unit 4: Missing plot technique - single observation missing in RBD. Estimation of missing observation by minimizing error sum of squares and analysis. Factorial experiment, 2^2 and 2^3 factorials - main effects and interactions, their best estimates and testing the significance when underlying design is RBD, Yates' algorithm. **...12L**

Books for Reference:

1. Hogg and Tanis. Probability and Statistical Inference, McMillan.
2. Hogg, R.V, McKean, J. W and Craig, A.T. (2013): Introduction to Mathematical Statistics, Seventh edition, Pearson.
3. Medhi, J. (1992): Statistical Methods - an introductory text, New Age Intl. Publications.
4. Mood, A.M, Greybill, F.A. and Boes, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
5. Rohatgi V.K. and Md. Ehsanes Salah, A.K. (2001): An Introduction to Probability Theory and Mathematical Statistics, John Wiley and Sons.
6. Goon, A.M., Gupta, M.K., Das Gupta, B. (1991): Fundamentals of Statistics, Vol.1 World Press, Calcutta.
7. Freund, J.E. and Walpole (1987): Mathematical Statistics, Prentice Hall India.
8. Ross, S.M. (1972) : Introduction to Probability Models, Academic Press.
9. Montgomery, D.C. (1991): Design and Analysis of Experiments, Wiley.
10. Das, M.N. and Giri, N.C. (1979): Design and Analysis of Experiments, Wiley Eastern.
11. Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling, Prentice Hall.
12. Kapoor, V.K. and Gupta, S. C. Fundamentals of Applied Statistics, Sultan Chand publications.

Discipline Specific Course (DSC):

Paper 8: Practical – 4 (2 Credits – 4 hours of Practical teaching per week)

Practicals (About 30 in number) .

1. Computation of probabilities of Type 1 and Type 2 errors, power of the test, power function, and sketching.
2. Construction of most powerful tests, UMP, MLR and computation of power.
3. Tests of significance of means, variances.
4. Tests of significance of proportions and large sample tests.
5. Tests of goodness-of-fit and tests of independence of attributes.
6. Nonparametric one and two sample tests.
7. QQ plots.
8. Computation of ANOVA for one-two way classification.

9. Computation of ANOVA for CRD, RBD, LSD.
10. Problems on missing plot technique in RBD.
11. 2^2 and 2^3 factorial experiments.

Fifth Semester

Discipline Specific Elective (DSE):

Paper 9: Sampling Techniques (3 Credits – 2 credits of Theory with two hours of theory teaching per week and 1 credit of Practical with 2 hours of practical teaching per week)

Unit 1: Introduction to Sampling Techniques. Population, Sample, Parameter, Estimator, Estimate, Problems associated with sample survey. Advantages of Sampling vis-a-vis Complete Enumeration. Basic Sampling Designs. 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. **...10L**

Unit 2: Stratified random sampling with SRSWR and SRSWOR. Estimation of population mean and total, standard error of estimators and estimation of standard errors. Allocation - Proportional, Neyman and Optimum allocations for fixed precision. Comparisons between stratified sampling and SRWOR in terms of precision and in terms of costs. Practical difficulties in adopting optimum allocations. **...10L**

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. Non sampling errors. Acquaintance with working of NSSO and other agencies, undertaking sample surveys (questionnaires, sampling design, method followed in field investigation, principal findings, etc.) **...8L**

Paper 10: Practical- (About 15 in number)

1. Construction of SRSWR / SRSWOR.
2. Problems on SRS for variables and attributes.
3. Stratified random sample.
4. Systematic sample.

Books for Reference:

1. Murthy, M.N. (1967): Sampling Theory and Methods. Stat. Publ. Society, Kolkata.
2. Cochran, W.G. (1984): Sampling Techniques. 3rd ed. Wiley Eastern.
3. Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall.
4. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1986): Fundamentals of Statistics, Vol.1, World Press, Kolkata.

Discipline Specific Elective (DSE):

Paper 11: Statistical Quality Control (SQC) and Reliability (3 Credits – 2 credits of Theory with two hours of theory teaching per week and 1 credit of Practical with 2 hours of practical teaching per week)

Unit 1: Importance of SQC, Meaning of Quality, Chance and Assignable Causes of Quality Variation. QC tools-1: Histogram, Stem-and-Leaf plot, Check List, Pareto analysis. Cause and Effect Diagram. Defect Concentration Diagram. Scatter Plot. **...7L**

Unit 2: Control Charts - Basis, Rational subgroups, natural tolerance and specification limits. Interpretation of patterns on X-bar-R Control charts, Control charts for Attributes - np, p, c and u charts - Basis, construction and interpretation. **… 7L**

Unit 3: Lot acceptance sampling - Single and Double attribute sampling plans. OC, AOQ, ASN and ATI curves, AQL, LQL, Producer's risk and Consumer's risk. Construction of Single Sampling Plan given two points on the OC curve. General description of sampling inspection tables - Military Standards. **...7L**

Unit 5: Reliability - Basic concepts, Definition, Series and Parallel Systems. Life Distributions, Reliability Function, Hazard Rate. Common Life Distributions - Exponential, Weibull. **…7L**

Paper 12: Practical- (About 15 in number)

1. QC –tools-1, Histogram, Scatter diagram , Stem and leaf diagram.
2. QC-tools-2: Cause and effect diagram, Check list, Pareto diagram.
3. Control charts for variables-1: X-bar –R-chart.
4. Control charts for variables-2: X bar- S chart.
5. Control charts for attributes -1: p and np charts.
6. Control charts for attributes -1: p and np charts.
7. Single sampling plan.
8. Double sampling plan.
9. Reliability- Reliability rate, hazard rate, Series and parallel system.
10. Life distribution – Problems based on Exponential and Weibull distribution.

Books for Reference:

1. Montgomery, C.D. (1999): Introduction to Statistical Quality Control, Wiley.
2. Cowden, D.G. (1960): Statistical Methods in Quality Control,. Asia Publ. House.
3. Grant, E.L. and Leavenworth, R.S. (1988): Statistical Quality Control, 6th ed. McGraw Hill.
4. Mustafi, C.K. (1988): Operations Research - Methods and Practice, Wiley Eastern.

Sixth Semester

Discipline Specific Elective (DSE):

Paper 13: Operations Research (3 Credits – 2 credits of Theory with two hours of theory teaching per week and 1 credit of Practical with 2 hours of practical teaching per week)

Unit 1: 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). **...7L**

Unit 2: 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). **...7L**

Unit 3: Inventory Models - Basic concepts, economic lot size models for the case of known uniform demand and instantaneous procurement (with and without shortages) - proof under continuity assumptions only. Problems with quantity discounts, problems with restrictions on capital and problems with restrictions on space. Replacement model for items which deteriorate with time. Group replacement of items which fail, staffing problem. **...9L**

Unit 5: 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. **...5L**

Paper 14: Practical-(About 15 in number)

1. Problems - formulation, solution by - graphical method, simplex algorithm, Charne's M-technique
2. Inventory Models-with and without shortages.
3. Problems with quantity discounts, with restrictions on capital and on space.
4. Replacement model for items which deteriorate with time.
5. Group replacement of items which fail, staffing problem.
6. Drawing of Project network
7. Critical path identification, slack time and float.

Books for Reference:

1. Taha, A. (1999): Operations Research, Ed. 6, MacMillan Publ. Co.
2. Hillier, F.S. and Libermann, G.J. (1995): Introduction to Operations Research, 6th ed., McGraw Hill.
3. Kantiswaroop, P.K., Gupta, M. (1990): Operations Research, 5th ed., Sultan Chand publications.
4. Sasieni, M., Yaspan, A. and Friedman, L. (1959): Operations Research - Methods and Problems. Wiley.
5. Mustafi, C.K. (1988): Operations Research - Methods and Practice, Wiley Eastern.

Discipline Specific Elective (DSE):

Paper 15: Applied Statistics (3 Credits – 2 credits of Theory with two hours of theory teaching per week and 1 credit of Practical with 2 hours of practical teaching per week)

Unit 1: Indian Applied Statistical system: Methods of collection of Official Statistics- National sample survey (NSS), Central Statistical Organization (CSO). Contribution of Mahalanobis to the development of sample survey theory. Index numbers - meaning and uses, selection of items to be included, choice of the base, mathematical formulae for computation of index numbers - based on arithmetic mean, Laspeyree, Paasche, Marshall-Edgeworth, Fisher's ideal Index numbers, weighted group index number, Time reversal, Factor reversal and circular tests, cost-of-living index numbers. **...9L**

Unit 2: Time Series Analysis: components of time series, measurement of trend by the method of moving averages, measurement of seasonal variation by the method of ratio to trend, measurements of cyclic variation. **...5L**

Unit 3: Demographic Methods: Sources of demographic data - census, registration, special demographic surveys, institutional data collection, limitations and uses in demographic studies, measurement of mortality- crude, specific and standardized death rates, infant mortality rates. Fertility, Measurement of fertility - crude birth rate, age specific, general and total fertility rates. Reproduction rates. Net Reproduction Rate, gross reproduction rates. **...7L**

Unit 4: Life table - components of a life table, forces of mortality and expectation of life table, construction of a life table, abridged life table due to Reed and Merrell, uses of life tables. Population growth - growth and rate of growth of population based on births, deaths and cross migrations. Population projection using logistic curve. **...7L**

Paper 16: Practical- (About 15 in number)

1. Computation of index number using averages of relatives, aggregative methods, consistency tests.
2. Measurement of trend by the method of moving averages.
3. Measurement of seasonal variation by the method of ratio to trend.
4. Measurements of cyclic variation.
5. Fertility rates, Mortality rates, life table, GRR,NRR.

Books for Reference:

1. Gupta, S.C. and Kapoor, V.K. (1976): Fundamentals of Applied Statistics, Sultan Chand.
2. Pathak, K.B. and Ram, F. (1991): Techniques of Demographic Analysis. Himalaya Pub. House.
3. Ashok Rudra (1996): Prasanta Chandra Mahalanobis - a biography. Oxford Univ. Press.
4. Umarji, R.R. (1962): Probability and Statistical Methods, 2nd ed., Asia Pub. House.
5. Goon, A.M., Guptha, M.K., and Das Gupta, B. (1986): Fundamentals of Statistics, Vol. 1, World Press, Kolkata.

Discipline Specific Elective (DSE):

Paper 17: Actuarial Statistics (3 Credits – 2 credits of Theory with two hours of theory teaching per week and 1 credit of Practical with 2 hours of practical teaching per week)

Unit 1: Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curate future lifetime, force of mortality. Life table and its relation with survival function examples, assumptions of fractional ages, some analytical laws of mortality select and ultimate tables**.** **...7L**

Unit 2: Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions, evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations. Distribution of aggregate claims, compound Poisson distribution and its applications. **...7L**

Unit 3: Elements of compound interest (nominal and effective rate of interest), Life annuities: single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, communication functions, varying annuities, recursions and complete annuities - immediate and apportionable annuities, due. **...7L**

Unit 4: Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionate premiums, commutation functions, and accumulation type benefits. Net premium reserves: continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or accounted continuous basis reserves at fractional durations. **...7L**

Paper 18: Practicals- (About 15 in number)

1. Computation of values of utility function.
2. Computation of various components of life tables.
3. Construction of multiple decrement table for deterministic survival group.
4. Determination of distribution function, survival function and force of mortality.
5. Construction of multiple decrement table for random survivorship group.
6. Construction of select, ultimate and aggregate mortality.
7. Calculation of pdf and distribution function of aggregate claims.
8. Computation of compound interest (nominal and effective rate of interests).
9. Annuities and annuity dues.
10. Computation of discrete and continuous net premiums.
11. Annuities payable more frequently than one year.
12. Complete and special annuities.
13. Office premium.
14. Assurances payable at the moment of death.

Books for Reference:

1. Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1986): Actuarial Mathematics, Society of Actuaries, Ithaca, Illinois,USA.
2. Neill, A.(1977): Life contingencies, Heineman.
3. Surgeon, E.T. (1972): Life contingencies, Cambridge University Press.
4. Benjamin, B. and Pollard, J.H. (1980): Analysis of Mortality and other Actuarial Statistics.
5. Federation of Insurance Institutes study courses: Mathematical basis of Life Assurance, F.I.21, Published by Federation of Insurance Institutes, Bombay.

Skill Enhancement Course (SEC):

Paper 19: Econometrics (2 Credits – Two hours of theory teaching per week)

Unit 1: The nature of Regression analysis Two-variable regression analysis, problem of estimation.

Unit 2: Classical Normal Linear Regression model (CNLRM). Two-variable Regression model: The problem of inference.Extension of two variable regression model.

Books for reference:

1. Damodar Gujarati: Basic Econometrics, Fourth edition, Mc- Graw Hill publications, First Nine chapters.
2. Johnston: Econometrics.

Skill Enhancement Course (SEC):

Paper 20: Statistical computing using R (2 Credits – Four hours of practical teaching per week)

Unit 1: Introduction to R: Methods of data input, data accessing, built-in function in R. Descriptive Statistics: Graphs and diagrams, measures of central tendency, dispersion, skewness and kurtosis.

Unit 2: Probability and probability distributions.Statistical inference. Correlation and regression analysis using R.

Books for reference:

3. Sharad D.G, Shylaja Deshmuck and Sudha G. Purohit,: (2008) Statistics using R. Narosa publications.
4. Michael Crawley: The R book, Wiley publications.
5. James, G., Witten, D, Hastie. T and Tibshirani. R. (2013): An Introduction to Statistical Learning (with Application in R), Springer.

Skill Enhancement Course (SEC):

Paper 21: Introduction to Latex- a documentation preparation system (2 Credits – Four hours of practical teaching per week)

Unit 1: Basics: Layout Design, Advantages and Disadvantages, LaTeX commands , Input File, Page Styles. Commands for Text Mode: different kinds of type, environment, Theorems, Lemmas, and Conjectures, Lists, Centering and Underlining, Spacing, Tables, Sectioning and Cross-references, Bibliography.

Unit 2: Commands for Math Mode: Numbered Equations,Subscripting and Superscripting, Text in Math Mode, Special Symbols, Bracketing, Matrices. Including Pictures: Xfig, picture environment, epic environment, Including PostScript code.

Books for reference:

1. Kopka, Helmut and Daly, Patrick W.: Guide to LATEX, Addison Wesley publications.
2. Mittelback, Frank and Gossens, Michel: The LATEX companion- tools and techniques for computer typesetting.
3. Kuhn, R., Scott, R. and Andreev, L. An Introduction to Using TEX, Harvard Mathematics Department, Open source.
4. Oetiker, Tobias: The Not So Short Introduction to LATEX, Open source.

Skill Enhancement Course (SEC):

Paper 22: Statistical methods in Biology- Self study (2 Credits) (Two hours of tutorials per week, if necessary)

Unit 1: Descriptive Statistics. Basic probability theory. Distribution theory- binomial, Poisson, Normal.

Unit 2: Testing of hypothesis-Z, t, F and chi square tests. Correlation and regression.

Books for reference:

1. Bhat B.R., Srivenkataramana T. and Rao, Madhava K.S. (1996): Statistics, A Beginner's Text, Vol. I and II, New Age International (P) Ltd.
2. Goon, A.M., Gupta, M.K. and Das Gupta, B. (1991): Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Belle, G.V, Fisher. L.D, Heagerty. P.J and Lumley. T. (2004): Biostatistics, Wiley series in Probability and Statistics.