

Cotton College State University

Department of Statistics

Undergraduate Syllabus (Revised – 2015)

Semester-wise Distribution of Papers and Credits

SEMESTER – I

Course	Paper	Credit per paper	Total Credit
Core	3	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+1(Tutorial)+0(Practical)	6
Compulsory	1	2	2
Total			20

SEMESTER – II

Course	Paper	Credit per paper	Total Credit
Core	3	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+1(Tutorial)+0(Practical)	6
Compulsory	1	2	2
Total			20

SEMESTER – III

Course	Paper	Credit per paper	Total Credit
Core	3	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+0(Tutorial)+1(Practical)	6
Compulsory	1	2	2
Total			20

SEMESTER – IV

Course	Paper	Credit per paper	Total Credit
Core	3	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+0(Tutorial)+1(Practical)	6
Compulsory	1	2	2
Total			20

SEMESTER – V

Course	Paper	Credit per paper	Total Credit
Core	2	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+0(Tutorial)+1(Practical)	6
Compulsory	1	2	2
Total			20

SEMESTER – VI

Course	Paper	Credit per paper	Total Credit
Core	2	2(Lecture)+1 (Tutorial)+1(Practical)	12
Elective	2	2(Lecture)+1(Tutorial)+0(Practical)	6
Compulsory	1	2	2
Total			20

Total Credit: 72 (Core) + 36 (Elective) + 12 (Compulsory)

Sem I + Sem II + Sem III + Sem IV + Sem V + Sem VI = 20+20+20+20+20+20=120

Semester-wise Distribution of Courses and Credits (Core)

SEMESTER – I

Course	Paper No.	Title	Credit
Core	STA 101 C	Statistical Methods –I	4 (2+1+1)
	STA 102 C	Probability –I	4 (2+1+1)
	STA 103 C	Numerical Analysis	4 (2+1+1)
Total			12

SEMESTER – II

Course	Paper No.	Title	Credit
Core	STA 201 C	Statistical Methods –II	4 (2+1+1)
	STA 202 C	Probability –II	4 (2+1+1)
	STA 203 C	Algebra-I	4 (2+1+1)
Total			12

SEMESTER – III

Course	Paper No.	Title	Credit
Core	STA 301 C	Algebra –II & OR-I	4 (2+1+1)
	STA 302 C	Probability –III	4 (2+1+1)
	STA 303 C	Applied Statistics-I	4 (2+1+1)
Total			12

SEMESTER – IV

Course	Paper No.	Title	Credit
Core	STA 401 C	Mathematical Analysis	4 (3+1+0)
	STA 402 C	Probability –IV	4 (2+1+1)
	STA 403 C	Stochastic Process, Bio Statistics & Applied Statistics-II	4 (2+1+1)
Total			12

SEMESTER – V

Course	Paper No.	Title	Credit
Core	STA 501 C	Statistical Inference -I	4 (2+1+1)
	STA 502 C	Sample Survey	4 (2+1+1)
	STA 503 C	Analysis of Variance & Design of Experiments	4 (2+1+1)
Total			12

SEMESTER – VI

Course	Paper No.	Title	Credit
Core	STA 601 C	Statistical Inference -II	4 (2+1+1)
	STA 602 C	Multivariate Analysis & OR -II	4 (2+1+1)
	STA 603 C	Computer Programming in C & Project Work	4 (2+1+1)
Total			12

DETAILED COURSES OF STATISTICS (CORE)

Semester I

STA 101 C: Statistical Methods –I

(2+1+1 = 4 Credits)

Statistical Methods: Concepts of statistical population and sample from a population, Quantitative and qualitative data, Nominal, Ordinal and time series data, Discrete and continuous data.

Collection and Scrutiny of Data: Primary data – Methods of collection, Designing a questionnaire and a schedule, Checking its consistency. Secondary data – its major sources, Complete enumeration, Sample Surveys, Scrutiny of data for internal consistency and detection of errors in recording, Ideas of cross-validation.

Presentation of data: Construction of tables with one or more factors of classification, Diagrammatic representations, Frequency distributions and cumulative frequency distributions and their graphical representations, Stem and leaf displays, Box Plot.

Measures of location (or central tendency) and Dispersion, Moments, Measures of skewness and kurtosis, Absolute moments and factorial moments, Cumulants, Inequalities concerning moments, Sheppard's corrections.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 102 C: Probability I

(2+1+1 = 4 Credits)

Probability Theory: Random experiments, Sample point and sample space, Events, Algebra of events. Definition of Probability – Classical, Relative frequency and Axiomatic approach; Merits and demerits of these approaches (only general ideas to be given), related examples; Theorems on probability, Conditional probability, Independent events, related problems. Bayes theorem and its applications. Idea of Geometrical probability.

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f., c.d.f., Expectation of Random variables and its properties, Theorems on sum and product of expectations of random variables, Moments, Measures of location and dispersion of random variable.

Bivariate case: The p.m.f., p.d.f and c.d.f. in bivariate case, Marginal and conditional distributions, Independence, Conditional expectation and conditional variance.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 103 C: Numerical Analysis

(2+1+1 = 4 Credits)

Finite Difference: Factorial with positive and negative index. Operators: Shift operator (E), Forward difference (Δ), Backward difference (∇), Central difference (δ), Average (μ), differential (D) and inter-relations between them, Finite differences of order n, Fundamental theorem of finite differences, Divided differences of order n.

Interpolation: Newton's Forward, Backward and Divided Difference interpolation formulae with error term, Lagrange's interpolation formula,

Central difference formulae: Gauss, Bessel, Everret and Stirling's formulae.

Lagrange's inverse interpolation formula, Numerical differentiation.

Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule and Weddle's rule with error term, Euler-Maclaurin's summation formula.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall of India (P) Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.I, 4th Edn. World Press, Kolkata.
4. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
5. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
6. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
7. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
8. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
9. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.

10. Saxena, H.C. (2005): Finite Differences and Numerical Analysis, 15th Revised Edn. (Reprint). S. Chand and Co.
11. Scarborough, J.B. (1966): Numerical Mathematical Analysis, 6th Edition. Oxford and IBH.
12. Spiegel M.R. (1988): Theory and problem of Statistics, Schaum's Publishing Series.

Semester II

STA 201 C: Statistical Methods –II

(2+1+1 = 4 Credits)

Curve fitting: Principles of least squares, Fitting of polynomial and exponential curves.

Correlation and Regression Analysis: Bivariate data – scatter diagram, Preparation of bivariate frequency table, Relation between variables, Correlation coefficient and its properties, Rank correlation – Spearman's and Kendall's measures. Correlation ratio, Correlation index, Intra-class correlation. Concept of regression, Fitting of linear regression and related results. Partial and multiple correlation and regression.

Analysis of Categorical Data: Consistency of data, Independence and Association of attributes, Measures of association – Pearson's and Yule's measures, Goodman-Kruskal's γ . Odds Ratio.

Tests of significance: Concepts of Statistics and Sampling Distributions of Statistics. Idea of null and alternative hypotheses, Level of significance and probabilities of Type I and Type II errors, Critical region and p-value, Large sample tests for single proportion, Difference of two proportions, Single mean, Difference of two means, Difference of standard deviations

Monte Carlo simulation: Drawing of random samples from a distribution, Verification of sampling distributions.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 202 C: Probability II

(2+1+1 = 4 Credits)

Generating Functions: Probability generating function (pgf), Convolution, Moment generating function (mgf) of a random variable, their properties and uses, Factorial moments and their properties, Cumulant generating function and its properties, Characteristic function and its simple properties.

Standard probability distributions: **Discrete** - Bernoulli, Binomial, Poisson, Geometric
Continuous - Normal and exponential.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 203 C: Algebra – I**(2+1+1 = 4 Credits)**

Matrix Algebra: Matrix-definition and related theorems, Idempotent and unitary matrices, Orthogonal matrix and its properties, Adjoint of a square matrix and related theorems, Inverse of a matrix, Rank of a matrix: sub matrix of a matrix, minors of a matrix, definition of rank, Theorems on rank, Elementary transformation of a matrix, Elementary matrices and related theorems, Echelon and normal form, Invariance of rank under elementary transformation, Rank of product.

Linear equations, Homogeneous and non homogeneous system of equations, Consistency and general solution, Eigen Values, Eigen vectors and related theorems, Cayley-Hamilton theorem.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Feller, W. (1993): An Introduction to Probability Theory and its Applications, Vol. I, 9th Wiley Eastern (Reprint).
2. Goon A.M. (1988) : Vectors and Matrices.
3. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
4. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.I, 4th Edn. World Press, Kolkata.
5. Graybill, F.E.(1961) :Introduction to Matrices with Applications in Statistics. Wadsworth Pub. Co.
6. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. I & Vol. II, 2nd Edn., John Wiley.
7. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Discrete Univariate Distributions, John Wiley.
8. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
9. Searle S.R. (1982): Matrix Algebra – useful for Statistics, John Wiley
10. Vasishtha, A. R. (1982): Matrices. 9th Edition, Krishna Prakashan Mandir

Semester III

STA 301 C: Algebra - II & OR - I

(2+1+1 = 4 Credits)

Unit 1

Quadratic forms: Definition, Matrix of a quadratic form - definition, Idea of positive definite, negative definite, semi-positive definite and semi-negative definite with simple examples.

General properties of linear difference equation, Linear difference equation with constant coefficient.

Roots of polynomial equations and solution of simple problems by Newton Raphson Method, Bisection Method, Graphical Method, Regula Falsi Method and Method of Iteration.

Unit 2

Definition of vectors, Algebra of vectors, Linear dependence and linear independence of vectors, Linear combination of vectors, Hyperplanes, Basis, Dimension, Properties of convex sets.

Optimization: Linear programming problem (LPP): Problem formulation and solution using graphical and simplex method.

Transportation Problem: Definition and its solution using north-west corner rule and Vogel's method.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 302 C: Probability III

(2+1+1 = 4 Credits)

Unit 1

Univariate Discrete Distributions: Uniform, Hypergeometric, Negative Binomial distributions and their properties.

Univariate Continuous Distributions: Rectangular, Cauchy, Gamma, Beta and their properties. Idea of Log-normal, Laplace, Logistic distributions.

Truncated distributions (Binomial, Poisson and Normal).

Unit 2

Order Statistics: Definition and uses of order Statistics, Derivation of the distribution of r^{th} ordered statistics. Joint distribution of the r^{th} & s^{th} order statistics, Distribution of sample range and sample median.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 303 C: Applied Statistics -I

(2+1+1 = 4 Credits)

Vital Statistics: Uses and sources: Census, Registration, Adhoc surveys, Hospital records. Mortality rates - CDR, SDR, STDR, IMR, along with their merits and demerits, Life Tables - Construction of a complete life table along with assumptions and uses, Concept of an abridged life table; Measurements of Fertility - CBR, GFR, SFR, TFR with their merits and demerits. Measures of population growth - Crude Rate of Natural Growth, GRR and NRR. Logistic curve, its fitting by the methods of (i) three selected points,(ii) Pearl and Reeds and (iii) Rhodes, its uses in population projection.

Statistical Quality Control (SQC): Theoretical basis of SQC, Different kinds of control charts - \bar{x} , R, p, and c-charts. Sampling Inspection Plan: Single Sampling Inspection Plan- Acceptance Quality level (AQL), Lot Tolerance Percent Defective (LTPD), Process Average Fraction Defective, Producer's Risk, Consumer's Risk, Average Outgoing Quality (AOQ), Average Outgoing Quality Limit (AOQL), Operating Characteristic (OC) curve, Average Sample Number (ASN) Curve and Average Amount of Total Inspection (ATI) Curve.

Time Series: Introduction, Decomposition of a time series, Different components with illustrations, Measurement of trend - Graphical Method, Method of semi-averages, Method of fitting curves (straight line, Polynomials, Growth curves-modified exponential curve, Gompertz curve and logistic curve), Method of moving averages, Measurement of seasonal variation- Method of simple averages, Ratio-to-trend method, Ratio to moving average method, Link relative method. Correlogram and Periodogram.

Official Statistics: Study of population Census in India (Highlights of last two censuses); Functions of NSSO and CSO, Functions of National Statistical Commission (NSC).

Index Numbers: Definition, Construction of index numbers by different methods, Problems faced in their construction, Criterion of a good index number, Time reversal, Factor reversal and circular tests, Errors in the construction of index numbers, Chain and fixed base index numbers, Base shifting, Splicing and deflating of index numbers, Cost of living index numbers- construction and uses. Wholesale price index.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall.
2. Feller, W. (1993): An Introduction to Probability Theory and its Applications, Vol. I, 9th Wiley Eastern (Reprint).
3. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
4. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.

5. Goon, A.M. (1988) : Vectors and Matrices.
6. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.I, 4th Edn. World Press, Kolkata.
7. Grant, E.L. (1999): Statistical Quality Control. Tata McGraw-Hill.
8. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
9. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
10. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Continuous Univariate Distributions, Vol. I & Vol. II, 2nd Edn., John Wiley.
11. Johnson, N.L., Kotz, S. and Balakrishnan, N. (1994): Discrete Univariate Distributions, John Wiley.
12. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13th Edn. Sultan Chand and Sons.
13. Montgomery, D.C. (2007): Introduction to Statistical Quality Control. John Wiley and Sons.
14. Mukhopadhyay, P. (1999): Applied Statistics. Books and Allied (P) Ltd.
15. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.
16. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
17. Vasishtha, A. R. (1982): Matrices. 9th Edition, Krishna Prakashan Mandir

Semester IV

STA 401 C: Mathematical Analysis

(3+1+0 = 4 Credits)

Unit 1

Limit, continuity and differentiability of functions of one variable.

Rolle's theorem, Mean value theorems (Lagrange's and Cauchy's), Taylor's expansion, maxima and minima.

Functions of several variables - limit, continuity and differentiability, Taylor's expansion for several variables.

Partial derivatives: basic idea and simple examples, Jacobian of transformation. Applications of Lagrange's multipliers.

Unit 2

Riemann integral, Infinite and improper integrals; Gamma and Beta integrals and their properties.

STA 402 C: Probability IV

(2+1+1 = 4 Credits)

Limit Laws: Convergence in probability, Almost sure convergence, Convergence in distribution. Chebyshev's inequality, WLLN, SLLN applications, De-Moivre-Laplace theorem, Levy-Lindberg theorem, Central limit theorem (C.L.T.) for i.i.d. variates, Liapunov theorem (without proof) and applications of C.L.T.

Transformation of random variables.

Some Standard Sampling Distributions : χ^2 distribution, Distributions of the mean and variance of a random sample from a normal population, t and F distributions, Tests of significance based on t, F and χ^2 distributions. Distributions of \bar{x} , S^2 , Correlation coefficient r (null case only).

****Practicals will be of 1 Credit and will be based on the above topics**

STA 403 C: Stochastic Process, Bio Statistics & Applied Statistics-II

(2+1+1 = 4 Credits)

Unit 1

Stochastic Process: Definition, Classification and illustrative examples of stochastic processes, Markov chain and Markov Process - definition and examples, Chapman Kolmogorov's equations and m-step transition probabilities, Idea of Random walk model. Absorbing and reflecting barriers, Classification of states. First passage probabilities.

Unit 2

Bio Statistics: Functions of survival time, Survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, Lognormal, Death density function for a distribution having bath-tub shape hazard function. Type I Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator of type I and type II censored data with numerical examples.

Unit 3

Demand Analysis: Income distributions. Pareto's income distribution, Gini's coefficient and Lorenz curve of concentration. Theory of consumption and demand, Demand and Supply curves, Elasticity of demand, Engel's law and curve.

Econometrics: Definition and scope of Econometrics. Relation between variables, Linear model: two or more variables, Least square assumptions, Estimation of regression parameters, Test of significance and confidence interval of parameters. Gauss Markov Theorem. BLUE, Problem of single equation model, Multicollinearity, Autocorrelation & Heteroscedasticity (brief idea of why it occurs –violation of least square assumptions).

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Biswas, S. (2004): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, 2nd Central Edn. New Central Book Agency.
2. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics. John Wiley and Sons.
3. Croxton, F.E., Cowden, D.J. and Klein, S. (1982): Applied General Statistics, 3rd Edn. Prentice Hall Wiley and Sons.
4. Feller, W. (1993): An Introduction to Probability Theory and its Applications, Vol. I, 9th Wiley Eastern (Reprint).
5. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
6. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
7. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
8. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 2nd Edn. John Wiley and Sons.
9. Madnani, G.M.K. (2008): Introduction to Econometrics-Principles and Application, 8th Edn. Oxford & IBH Publishing House.
10. Malik S.C. & Arora S. (1991): Mathematical Analysis, 2nd Edition, Wiley Eastern Ltd.
11. Malik, S. C. (1987): Mathematical Analysis, 4th Edition, Wiley Eastern Ltd.
12. Medhi, J. (2008): Stochastic Processes, 2nd Edn. (Reprint). New Age International.
13. Narayan, Shanti: Mathematical Analysis, Sultan Chand and Sons.
14. Rohatgi, V. K. and Saleh, A. K. Md. E. (2009): An Introduction to Probability and Statistics, 2nd Edn. (Reprint). John Wiley and Sons.

Semester V

STA 501 C: Statistical Inference –I

(2+1+1 = 4 Credits)

Estimation: Parametric space, Sample space, Point estimation. Requirements of good estimator: Consistency, Unbiasedness, Efficiency, sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality. Minimum Variance Bound (MVB) estimators, Rao-Blackwell theorem, Lehmann-Scheffe theorem. Methods of estimation: Maximum likelihood, Moments, Minimum chi-square, Least squares and Minimum Variance. Properties of maximum likelihood estimators.

Interval estimation: Confidence intervals for the parameters of various distributions. Confidence intervals for difference of means and for ratio of variances, Confidence interval for binomial proportion and population correlation coefficient when population is normal, Pivotal quantity method of constructing confidence interval, Large sample confidence intervals.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 502 C: Sample Survey

(2+1+1 = 4 Credits)

Basic Concepts: Population and sample. Complete enumeration vs sampling, Need for sampling, Principal and organisational aspects in the conduct of a sample survey. Sampling frame and sampling unit, Idea of construction of sampling frame for a statistical enquiry, Optimum size and structure of sampling units, Use of pilot survey, Sampling and Non sampling errors and their control.

Sampling Techniques: Simple Random Sampling, Stratified Random Sampling including various types of allocation, Calculation and comparison of precision level, Cost and variance functions, Multistage (two stage) Sampling, Cluster Sampling, Systematic Sampling, Double Sampling - Ratio, Regression and product estimates, Sampling with probability proportional to size.

Estimation procedures: Estimates of population total and mean, Bias in estimates, Standard error of estimates of the above sampling techniques.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 503 C: Analysis of Variance & Design of experiments

(2+1+1 = 4 Credits)

Analysis of variance: One-way and two-way classified data with m (≥ 1) observations per cell for fixed effects models. Assumptions and effects of violation of the assumptions. Analysis of Covariance: One-way and two-way classified data with one concomitant variable.

Experimental designs: Terminology, Experimental error, Basic principles, Uniformity trials, Choice of size and shape of plots and blocks.

Basic designs: Completely randomized design (CRD), Randomized block design (RBD), Latin square design (LSD) – layout, model and statistical analysis, Relative efficiency, Analysis with missing observations. Split Plot design and Idea of Strip Plot arrangements (without analysis).

Factorial experiments: Advantages, notations and concepts of 2^2 , 2^3 , 2^n and 3^2 factorial experiments; design and analysis, Total, Partial and Balanced confounding for 2^n ($n \leq 5$) and 3^2 factorial experiments.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Cochran, W.G. (1977): Sampling Techniques. John Wiley and Sons, N.Y.
2. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
3. Das, K. K. and Bahttacharjee, D. (2008): A Treatise on Statistical Inference and Distributions, Asian Books Private Ltd., New Delhi.
4. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
6. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.II, 4th Edn. World Press, Kolkata.
7. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata.
8. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
9. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
10. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
11. Rao, C. R. (1973): Linear Statistical Inference and its Applications. 2nd Edition, Wiley Eastern.
12. Rohatgi, V. K. (1984): Statistical Inference. John Wiley and Sons.
13. Saxena, H. C. and Surindran, P. U. (1985): Statistical Inference. 3rd Edition, S. Chand and Co.
14. Singh, D. and Chaudhary, F.S. (1995): Theory and Analysis of Sample Survey Designs. New Age International (P) Ltd.
15. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984): Sampling Theory of Surveys with Applications. Iowa State University Press, Iowa, USA

Semester VI

STA 601 C: Statistical Inference– II

(2+1+1 = 4 Credits)

Testing of Hypothesis: Statistical hypothesis, Simple and composite hypotheses. Test of statistical hypotheses, Null and alternative hypotheses. Critical region. Two kinds of errors. Level of significance and power of a test. Consistency and relative efficiency of tests. MP test and region. Neyman-Pearson Lemma, Critical regions for simple hypotheses, for one parameter. Randomized test. UMPU Test and region. Likelihood ratio test, properties of LR tests (without proof). Sequential Probability Ratio Test. Determination of stopping bounds A and B, OC and ASN functions of SPRT.

Bayesian Inference: Introduction - Decision Theory, Basic Concepts, Bayes and Minimax decision rules, Different types of Loss functions, Idea of Prior & Posterior distributions, Estimation of Parameters - Bayes estimator and Minimax estimator with simple examples.

Non- Parametric Test: Need for non-parametric tests, Chi- square test, Kolmogrov- Smirnov test (one and two samples), Run test (one and two samples), Sign test for location of univariate and bivariate population, Median test, Spearman rank correlation, Kendall's Tau, Mann-Whitney test, Wilcoxon signed rank test (derivation of tests not required; their application and use to be stressed upon).

****Practicals will be of 1 Credit and will be based on the above topics**

STA 602 C: Multivariate Analysis and OR–II

(2+1+1 = 4 Credits)

Unit 1

Bivariate Normal Distribution: Properties; Marginal and Conditional distributions, Independence.

Multivariate Normal distribution: Properties, Marginal and conditional distribution, Independence, Characteristic function, Hotelling T^2 - idea and application (without derivation). Multinomial distribution.

Unit 2

Replacement and Maintenance: Replacement of items with deterministic deterioration (items that deteriorate with time), Group replacement policy.

Network: Idea of Network diagram, Event, Different types of activities, Construction of network diagram.

Network scheduling using C.P.M: Determination of different types of floats and slacks, Determination of Critical path.

PERT: Basic definition of PERT and its usefulness, Idea of optimistic time, pessimistic time and most likely time, Calculation of normal time and variance, Determination of optimum schedule under normal distribution.

****Practicals will be of 1 Credit and will be based on the above topics**

STA 603 C: Computer Programming in C and Project Work

(2+1+1 = 4 Credits)

Unit 1

1+1 = 2 Credits

Basic idea of different parts of a computer, brief idea of Software, Hardware; High level languages. Preliminary idea of algorithms, Flowcharts, Compilers, Representation of integer and real numbers.

Basic element of a C program, Arithmetic operators, Precedence rules, Different data types-Integer, floating point, double precision and character, Constants and Variables, Formatted input & output, Relational and logical operations, IF - ELSE statement, WHILE statement, FOR statement, DO statement, Nesting; Arrays; String fundamentals. Writing small programs for determination of commonly used statistical measures and for carrying out simple statistical analysis.

****Practicals will be of 1 Credit and will be based on the above topics**

Unit 2

2 Credits

Computer oriented project work using Statistical data.

Books Recommended:

1. Arora, P. N., Arora, S. and Arora, S. (2007): Statistical Methods, S. Chand & Company Ltd.
2. Das, K. K. and Bahttacharjee, D. (2008): A Treatise on Statistical Inference and Distributions, Asian Books Private Ltd., New Delhi.
3. Goel, B. S. and Mittal, S. K. (2004): Operations Research, 21st Edition, Pragati Prakashan.
4. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol.II, 4th Edn. World Press, Kolkata.
6. Kantiswarup, Gupta, P.K. and Manmohan (2008): Operations Research, 13th Edn. Sultan Chand and Sons.
7. Let us C. Yashavant Kanetkar, 10th Edition, BPB publication.
8. Mukhopadhyay, P. (1996): Mathematical Statistics, New Central Book Agency.
9. Rao, C. R. (1973): Linear Statistical Inference and its Applications. 2nd Edition, Wiley Eastern.
10. Rohatgi, V. K. (1984): Statistical Inference. John Wiley and Sons.

11. Saxena, H. C. and Surendran, P. U. (1985): Statistical Inference. 3rd Edition, S. Chand and Co.
12. Sinha, S. K. (1988): Bayesian Estimation. New Age Internationnal (P) Ltd.
13. Taha, H.A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall of India.
14. V. Rajaraman, Fundamentals of computers, PHI Publications.

Semester-wise Distribution of Courses and Credits (Elective)

SEMESTER – I

Course	Paper No.	Title	Credit
Elective	STA 104E	Statistical Methods & Numerical Analysis –I	3 (2+1+0)
Total			3

SEMESTER – II

Course	Paper No.	Title	Credit
Elective	STA 204E	Probability	3 (2+1+0)
Total			3

SEMESTER – III

Course	Paper No.	Title	Credit
Elective	STA 304E	Statistical Methods & Numerical Analysis–II	3 (2+0+1)
Total			3

SEMESTER – IV

Course	Paper No.	Title	Credit
Elective	STA 404E	Applied Statistics	3 (2+0+1)
Total			3

SEMESTER – V

Course	Paper No.	Title	Credit
Elective	STA 504E	Sample Survey & Design of Experiments	3 (2+0+1)
Total			3

SEMESTER – VI

Course	Paper No.	Title	Credit
Elective	STA 604E	Statistical Inference	3 (2+1+0)
Total			3

DETAILED COURSES OF STATISTICS (Elective)

Semester I

STA 104 E: Statistical Methods & Numerical Analysis –I

(2+1+0=3 Credits)

Unit 1

Statistical Methods: Concepts of statistical population and sample from a population, Quantitative and qualitative data, Nominal, Ordinal and time series data, Discrete and continuous data.

Collection and Scrutiny of Data: Primary data – Methods of collection, Designing a questionnaire and a schedule. Secondary data – its major sources, Complete enumeration.

Presentation of data: Construction of tables with one or more factors of classification, Graphical representations of non-frequency data. Frequency distribution, Cumulative frequency distributions and their graphical representations, Histogram, Frequency polygon and Ogive.

Measures of location (or central tendency) and Dispersion, Moments, Measures of skewness and kurtosis, (derivation of formulae for the measures not required), Sheppard's corrections for moments for grouped data (without derivation).

Unit 2

Finite Difference: Definition, Operators: Shift operator (E), Forward difference (Δ), Backward difference (∇), their properties. Difference table, Fundamental theorem of finite differences, Missing terms,

Interpolation: Definition, Newton's forward and Backward interpolation formula.

Divided Difference: Definition, Divided difference table, Newton's divided difference formula. Lagrange's interpolation formula,

Books Recommended:

1. Arora, P. N., Arora, S. and Arora, S. (2007): Statistical Methods, S. Chand & Company Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Saxena, H.C. (2005): Finite Differences and Numerical Analysis, 15th Revised Edn. (Reprint). S. Chand and Co.
6. Scarborough, J.B. (1966): Numerical Mathematical Analysis, 6th Edition. Oxford and IBH.

Semester II

STA 204 E: Probability

(2+1+0=3 Credits)

Probability Theory: Random experiments, Sample point and sample space, Events, Algebra of events. Definition of Probability – Classical, Relative frequency and Axiomatic approach; Merits and demerits of these approaches (only general ideas to be given), related examples; Theorems on probability, Conditional probability, Independent events, related problems. Bayes theorem and its applications.

Random Variables: Discrete and continuous random variables (Univariate), p.m.f., p.d.f., c.d.f., Expectation of Random variables and its properties, Theorems on sum and product of expectations of random variables, Moments, Measures of location and dispersion of random variable.

Bernoulli, Binomial, Poisson and Normal distribution (Normal Distribution without derivation), Chebychev's inequality, WLLN (without proof), Central Limit Theorem (without proof).

Books Recommended:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.

Semester III

STA 304 E: Statistical Methods & Numerical Analysis – II

(2+0+1=3 Credits)

Unit 1

Correlation & Regression: Product moment correlation coefficient and its properties; Principle of least squares; Scatter diagram; Linear regression; Regression lines, Regression coefficients, Angle between two lines of regression (with derivation). Idea of Partial and multiple correlation with examples.

Theory of attributes: Independence and association of attributes, Measures of association and contingency.

Sampling Distribution: Idea of Population and Sample, Estimate, Parameter and Statistic, Sampling Distribution, Standard Error, Idea of hypothesis, Type I and Type II error, level of significance. Statement and applications of χ^2 , t, and F distribution, large sample tests and confidence interval of sample mean and proportion.

Unit 2

Numerical integration: Introduction, General quadrature formula, Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule (all theorems, formulae, rules without derivation). Roots of polynomial equations and solution of simple problems by Newton Raphson Method.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Arora, P. N., Arora, S. and Arora, S. (2007): Statistical Methods, S. Chand & Company Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, 8th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn., (Reprint), Sultan Chand and Sons.

4. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Saxena, H.C. (2005): Finite Differences and Numerical Analysis, 15th Revised Edn. (Reprint). S. Chand and Co.
6. Scarborough, J.B. (1966): Numerical Mathematical Analysis, 6th Edition. Oxford and IBH.

Semester IV

STA 404 E: Applied Statistics

(2+0+1=3 Credits)

Vital Statistics: Introduction, Sources, Definition of rates, Mortality Rates: Crude Death Rate (CDR), Age Specific Death Rate (ASDR), Standardized Death Rates, Life Tables – Idea, different columns of a complete life table, Fertility Rates: Crude Birth Rate (CBR), General Fertility Rate, Age Specific Fertility Rates (ASFR), Total Fertility Rate (TFR), Reproduction Rates: Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

Index number: Definition, Construction of index number, Different formulae, Tests of index number, Chain base index number, Cost of Living Index Number – definition, data collection, construction and uses. Wholesale price index number.

Time Series: Concept and definition, Components, Multiplicative and additive models, Trend determination by curve fitting and moving average methods, Determination of seasonal indices: Method of simple averages, Ratio-to-trend method, Ratio to moving average method, Link relative method.

Statistical Quality Control: Theoretical basis of statistical quality control in industry Tolerance and specification limits. Different kinds of control charts: \bar{x} , R, p, and c-charts.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
2. Grant, E.L. (1999): Statistical Quality Control. Tata McGraw-Hill.
3. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.

Semester V

STA 504 E : Sample Survey & Design of Experiments

(2+0+1=3 Credits)

Unit 1

Sample Survey: Idea, Basic Principles, Biases, Steps involved in a large scale sample survey, Judgment sampling, Simple random sampling (with and without replacement), Stratified random sampling - idea and advantages, Allocation of sample size: Proportional and Optimum allocations, Idea of systematic and Two stage sampling.

Unit 2

Design of experiments: Linear models, Assumptions, Analysis of Variance (AOV) of one way and two way classified data, Basic principles of Design of experiments, Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Factorial experiment- 2^2 and 2^3 experiment (without confounding), Idea of missing plot experiments.

****Practicals will be of 1 Credit and will be based on the above topics**

Books Recommended:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
2. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.

Semester VI

STA 604 E: Statistical Inference

(2+1+0=3 Credits)

Unit 1

Estimation: Parametric space, Sample space, Point estimation. Requirements of good estimator: Consistency, Unbiasedness, Efficiency, Sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Methods of estimation: Maximum likelihood, moments.

Unit 2

Testing of Hypothesis: Statistical hypothesis, Simple and composite hypotheses. Test of statistical hypotheses, Null and alternative hypotheses. Critical region. Two kinds of errors. Level of significance

and power of a test. Consistency and relative efficiency of tests. MP test and region. Neyman-Pearson Lemma, Critical regions for simple hypotheses, for one parameter.

Books Recommended:

1. Arora, P. N., Arora, S. and Arora, S. (2007): Statistical Methods, S. Chand & Company Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. II, 8th Edn. World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4th Edn., (Reprint), Sultan Chand and Sons.
