YEAR 2: SEMESTER **III**

Course Code	Course Title	Course Type	Credit	Class hour/ week	Marks				Total Marks
					Internal		End-Sem		
					Th	Pr	Th	Pr	
ST-M-3-T ST-M-3-P	Linear Algebra and Numerical Analysis (Theo & Prac)	Major	4+2=6	6	10	5	40	20	75
ST-MI-3-T ST-MI-3-P	Basic Probability and Probability Distributions (Theo & Prac)	Minor	3+1=4	4	7	3	28	12	50
ST-MU-3-T	Introductory Inference	Multi-disciplinary	3	3	10	-	35	-	45
ST-SEC-3-T	Research Methodology	Skill Enhancement	3	3	10	-	35	-	45
Total			16	16	45		170		215

YEAR 2: SEMESTER **IV**

Course Code	Course Title	Course Type	Credit	Class hour/ week	Marks				Total Marks
					Internal		End-Sem		
					Th	Pr	Th	Pr	
ST-M-4.1-T ST-M-4.1-P	Inference-I and Sampling Distribution (Theo & Prac)	Major	4+2=6	6	10	5	40	20	75
ST-M-4.2-T ST-M-4.2-P	SQC and Demography (Theo & Prac)	Major	4+2=6	6	10	5	40	20	75
ST-MI-4-T ST-MI-4-P	Same as Semester III	Minor	4	4	10	-	40	-	50
AECC-2	MIL	Ability Enhancement	4	4	10		40		50
ST-SI-2	Summer Internship (Additional for Certificate/ Diploma)	Internship	4	4					
Total			20(24)	20(24)	50		200		250

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Paper: ST-M-3-T   Linear Algebra and Numerical Analysis (Theoretical)   Course
Type: Major   Credit 4   Marks 50

Linear Algebra

Unit 1
Vector: Vector space with a field of real numbers, addition and scalar multiplication of vectors, linear combination and linear independence, basis, dimension, subspace, inner-product, orthogonality and Gram-Schmidt orthogonalization process. (8L)

Unit 2
Matrix: Definition, various types of matrices, matrix operations, elementary matrices, rank of a matrix and related results, inverse of a matrix, determinants, cofactors, properties of determinants, Laplace expansion, determinant and inverse of a partitioned matrix, reduction of a matrix to normal form, triangular reduction. Homogeneous and non-homogeneous system of linear equations, consistency. Characteristic equation, eigenvalues and eigenvectors and simple related results regarding real symmetric matrices.
Quadratic forms: classification, canonical reduction, spectral decomposition. (16L)

Numerical Analysis

Unit 3
Approximation of numbers and functions, absolute and relative errors, Δ and E operators, separation of symbols using Δ and E operators.
Difference table, interpolation by Newton's forward and backward formula with error terms, Lagrange's formula, divided difference table, Newton's divided difference formula, Stirling's and Bessel's central difference interpolation formula. (10L)

Unit 4
Numerical differentiation and its applications.
Numerical integration, quadrature formula, trapezoidal, Simpson's ⅓ rd and ⅜ th rules.
Numerical solution of equations, bisection, iterative and Newton-Raphson methods in one unknown, conditions of convergence.
Stirling's approximation to n! (10L)

Paper: ST-M-3-P   Linear Algebra and Numerical Analysis (Practical)   Course Type:
Major   Credit 2   Marks 25

1. Problems on subspace and dimension of a vector space
2. Gram-Schmidt orthogonalization process
3. Finding rank and inverse of a matrix
4. Finding eigenvalues and eigenvectors of matrices

5. Problems on quadratic forms
6. Construction of difference tables and applications of interpolation formulas.
7. Applications of quadrature formulas
8. Numerical solution of equations

Suggested Reading:

1. Shanti Narayan: A Text Book on Matrices, S. Chand
2. Hadley, G: Linear Algebra, Addison Wesley, Narosa.
3. Rao, A. R. and Bhimasankaram, P.: Linear Algebra.
4. Scarborough, J. B.: Numerical Mathematical Analysis, Oxford University Press.
5. Saxena, H. C.: The Calculus of Finite Differences, S. Chand.
6. Freeman, H.: Finite Differences for Actuarial Students, Cambridge University Press.
7. Aitkinson, K.: Elementary Numerical Analysis, Wiley.

Paper: ST-MI-3-T   Basic probability and Probability Distributions (Theoretical)
     Course Type: Minor   Credit 4   Marks 50

Unit 1
Probability: Introduction, random experiments, sample space, events and algebra of events.Definitions of Probability – classical, statistical, and axiomatic. Related problems.
                                                                    (10L)

Unit 2
Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.   (8L)

Unit 3
Random variables: discrete and continuous random variables, p.m.f. , p.d.f. and c.d.f., statement of properties of c.d.f. , illustrations and properties of random variables. Mathematical Expectation (discrete and continuous), Probability generating function. Moments. Moment generating function. Probability Inequalities**:** Markov & Chebyshev.

                                                                    (10L)

Unit 4
Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, beta and gamma.   (8L)

Unit 5
Two dimensional random variables: discrete type, joint, marginal and conditional p.m.f andc.d.f., statement of properties of c.d.f, independence of variables, Correlation

coefficient, Conditional expectation and variance. Trinomial distribution.   (8L)

Paper: ST-MI-2-P   Basic Probability and Probability Distributions (Practical)   Course Type: Minor   Credit 1   Marks 15

1. Application problems based on Classical Definition of Probability.
2. Application problems based on Bayes' Theorem.
3. Fitting of binomial distributions for given n and p.
4. Fitting of binomial distributions after computing mean and variance.
5. Fitting of Poisson distributions after computing mean.
6. Application problems based on binomial distribution.
7. Application problems based on Poisson distribution.
8. Application problems based on negative binomial distribution.
9. Problems based on area property of normal distribution.
10. Application based problems using normal distribution.
11. Fitting of normal distribution when parameters are not given.

Suggested Reading:

1. Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.
2. Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.
3. Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), WorldPress.
4. Parzen, E. (1972): Modern Probability Theory and its Applications, John

   Wiley .

5. Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.

6. Cacoullos, T. (1973): Exercises in Probability. Narosa.

7. Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffen.

8. Ross, S. (2002): A First Course in Probability, Prentice Hall.

Paper: ST-MU-3-T   Introductory Inference   Course Type: Multidisciplinary

Credit 3   Marks 45

Unit 1

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). Basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems). (10L)

Unit 2
Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chisquare test, Yates' correction. (5L)

Unit 3
Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test. (5L)

Unit 4
Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design. (10L)

Suggested Reading:
1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences.
John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II
(2005).
3. Das, M. N. & Giri, N. C.: Design and Analysis of Experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences.(1964, 1977) by
John Wiley.
5. Bancroft, Holdon: Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
6. Goldstein, A: Biostatistics-An introductory text (1971). The Macmillan, New York.

Paper: ST-SEC-3-T   Research Methodology   Course Type: Skill Enhancement

Credit 3   Marks 45

Unit 1

Introduction to research, meaning of research, role of research in important areas, process of research, types of research, Unit of analysis, characteristics of interest. Research problem as a problem of hypothesis testing. (8L)

Unit 2

Data Processing: Introduction, editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data (8L)

Unit 3

Data Analysis: An overview on techniques in univariate, bivariate and multivariate data Models and Model Building: role of models, types of models, objectives of modeling, model building/ model development, model validation, simulation models.   (8L)

Unit 4

Formats of Reports: introduction, parts of a report, cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading.

Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.   (8L)

Suggested Reading:

1. Kotahri, C.R (2009): Research Methodology: Methods and Techniques, 2nd Revised Ed. Reprint, New Age International Publishers

2. Lilien, Gary L. and Philip Kotler, 1983. Marketing Decision Making; A Model

Building Approach, Harper & Row, New York.

3. Shenoy, GVS, et al., (1983). Quantitative Techniques for Managerial Decision

   Making, Wiley Eastern.

Paper: ST-M-4.1-T   Inference I and Sampling Distribution (Theoretical)   Course Type: Major   Credit 4   Marks 50

Unit 1
Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications).   (14L)

Unit 2
Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Bayes estimators.   (10L)

Unit 3
Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.   (10L)

Unit 4
Exact sampling distribution: Definition and derivation of p.d.f. of $\chi 2$ with n degrees of freedom using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of
$\chi 2$ distribution. Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f.,nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n1,n2)$. Relationship between t, F and $\chi 2$ distributions. Test of significance and confidence Intervals based on t and F distributions.   (16L)

Paper: ST-M-4.1-P   Inference I and Sampling Distribution (Practical)   Course Type: Major   Credit 2   Marks 25

List of Practical
1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Cramer-Rao inequality and MVB estimators

4. Sufficient Estimators – Factorization Theorem, Rao-Blackwell theorem, Complete Sufficient estimators
5. Lehman-Scheffe theorem and UMVUE
6. Maximum Likelihood Estimation

7. Estimation by the method of moments, minimum Chi-square
8. Applications of simple tests of significance
9. Applications of large sample tests of significance using CLT.

Suggested Reading:
1. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), An Outline of Statistical Theory, Vol. I, World Press, Calcutta
3. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
4. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
5. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
6. Mood A.M, Graybill F.A. and Boes D.C,: Introduction to the Theory of Statistics, McGraw Hill.
7. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
8. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. Iowa State University Press.

Paper: ST-M-4.2-T   SQC and Demography (Theoretical)   Course Type: Major
          Credit 4   Marks 50

SQC

Unit 1
Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, Quality system and standards: Introduction to ISO quality standards, Quality registration.   (4L)

Unit 2
Statistical Process Control - chance and assignable causes of quality variation. Statistical Control Charts - Construction and Statistical basis of 3σ Control charts, Rational Sub-grouping.
Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart.
Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.   (15L)

Demography

Unit 3
Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. age and sex), IMR, Standardized death rates.   (7L)

Unit 4
Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR. Graduation of mortality rates by Gompertz and Makeham's laws, logistic curve and its fitting by Rhodes' method for population forecasting.   (12L)

Paper: ST-M-4.2-P   SQC and Demography (Practical)   Course Type: Major
                Credit 2   Marks 25

   1.   Construction and interpretation of statistical control charts:
• X-bar & R-chart
• X-bar & s-chart
• np-chart
• p-chart
• c-chart

   2.   Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves

   3.   Calculation of different birth and death rates.
   4.   Construction of life tables
   5.   Calculation of different fertility rates.
   6.   Graduation of mortality rates by Gompertz law.
   7.   Logistic curve fitting by Rhodes' method

Suggested Reading:

1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011):Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.

Paper: ST-MI-4-T & ST-MI-4-P   Basic Probability and Probability Distributions (Theo & Prac)   Course Type: Minor   Credit 4+2   Marks 50+25