College of Arts, Science & Commerce (Autonomous)

SIES

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE

Sion (West), Mumbai – 400022.

Department of Statistics

Program: B.Sc.

Syllabus for S.Y.B.Sc.
Semester III & IV

(To be implemented from 2024 onwards)

Credit Based Semester and Grading System
National Education Policy

SEMESTER III

THEORY MAJOR

TITLE OF COURSE	PROBABILITY DISTRIBUTIONS			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
	I	**UNIVARIATE RANDOM VARIABLES(DISCRETE AND CONTINUOUS)**	**1**	**3**
	II	**STANDARD DISCRETE PROBABILITY DISTRIBUTIONS**	**1**	
	III	**BIVARIATE PROBABILITY DISTRIBUTIONS**	**1**	
TITLE OF COURSE	**THEORY OF SAMPLING**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
	I	**CONCEPTS OF SAMPLING & SIMPLERANDOM SAMPLING**	**1**	**3**
	II	**STRATIFIED SAMPLING**	**1**	
	III	**RATIO & REGRESSION ESTIMATIONAND SAMPLING METHODS**	**1**	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
	PROBABILITY DISTRIBUTIONS	**2**	**1**
	THEORY OF SAMPLING	**2**	**1**

SEMESTER IV

THEORY MAJOR

TITLE OF COURSE	PROBABILITY AND SAMPLING DISTRIBUTIONS			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
	I	**STANDARD CONTINUOUS PROBABILITY DISTRIBUTIONS**	**1**	**3**
	II	**NORMAL DISTRIBUTION**	**1**	
	III	**EXACT SAMPLING DISTRIBUTIONS**	**1**	
TITLE OF COURSE	**ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS**			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
	I	**ANALYSIS OF VARIANCE**	**1**	**3**
	II	**DESIGN OF EXPERIMENTS**	**1**	
	III	**LATIN SQUARE DESIGN & FACTORIAL EXPERIMENTS**	**1**	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
	PROBABILITY AND SAMPLING DISTRIBUTIONS	**2**	**1**
	ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS	**2**	**1**

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER III

PAPER I

- To be well versed with data collection techniques.
- To effectively use data visualization and summarization techniques to understand data.
- To understand the concepts of probability and random variable.

Course Code	Title	Credits
	PROBABILITY DISTRIBUTIONS	**3 Credits**
UNIT I: UNIVARIATE RANDOM VARIABLES (DISCRETE AND CONTINUOUS) Moment Generating Function, Cumulant generating Function and Characteristic function-Definition and properties: Effect of change of origin and scale, MGF, CGF and Characteristic function of sum of n independent random variables, moments from MGF, CGF and Characteristic function. Relationship between moments and cumulants. Transformation of univariate random Variable.		**15 Lectures**
UNIT II: STANDARD DISCRETE PROBABILITY DISTRIBUTIONS Degenerate, Uniform, Two point, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric, Truncated Binomial, Truncated Poisson(point of truncation 0) distributions. The following aspects (wherever applicable) of the above distributions to be discuss Probability mass function, Cumulative distribution function, Mean, Mode and Standard deviation. Moment Generating Function, Cumulant Generating Function, Additive property, Recurrence relation for Central Moments, Skewness and Kurtosis, Limiting distribution, Fitting of Distribution.		**15 Lectures**
UNIT III: BIVARIATE PROBABILITY DISTRIBUTIONS Joint Probability mass function for Discrete random variables**,** Joint Probability density function for continuous random variables and properties. Marginal and conditional Distributions. Independence of Random Variables. Conditional Expectation & Variance. Regression Function. Coefficient of Correlation. Transformation of Random Variables and Jacobian of transformation.		**15 Lectures**

SEMESTER III: PRACTICALS BASED ON PAPER I

1. Moment Generating Function,
2. Cumulant Generating Function, Characteristic Function,
3. Standard Discrete Distributions.
4. Fitting of Standard Discrete Distributions.
5. Bivariate Probability Distributions.
6. Transformation of univariate random variables.
7. Transformation of bivariate continuous random variables.

REFERENCES:

1. Goon A.M., Gupta M.K & Dasgupta B. (2013). *An Outline of Statistical Theory*,
2. Gupta S.C.&Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand & Sons
3. Hoel P. G. (1966). *Introduction to Mathematical Statistics*, Fourth Edition : John Wiley & Sons Inc.
4. Hogg R. V.&CraigA.T.(2012). *Introduction to Mathematical Statistics*, Seventh Edition: CollierMcMillan Publishers.
5. Hogg R. V.&Tannis E. A. (1988). *Probability and Statistical Inference*, Third Edition: CollierMcMillan Publishers.
6. Kapur J. N.&SaxenaH.C.*Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Medhi J. (2013). *Statistical Methods*; *An Introductory Text*, SecondEdition: Wiley Eastern Ltd.
8. Miller I., Miller M.& Freund J.E.(1999)*John E. Freund's Mathematical Statistics*, Sixth Edition:Pearson Education Inc.
9. MoodA. M., GraybillF.A., &BoyesD. C. (2001). *Introduction to the theory of Statistics,* ThirdEdition: McGraw-Hill Book Company. Vol. 1, Third Edition: The World Press Pvt. Ltd.

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER III

PAPER II

- To learn different methods of data collection.
- To analyse the collected data using sampling techniques.

Course Code	Title	Credits
	THEORY OF SAMPLING	**3 Credits**
UNIT I: CONCEPTS OF SAMPLING & SIMPLE RANDOM SAMPLING Population, Population unit, Sample, Sample unit, Parameter, Statistic, Estimator, Bias, Unbiasedness, Mean square error & Standard error. Census survey, Sample Survey. Steps in conducting a sample survey, Designing appropriate Questionnaire. Sampling and Non-sampling errors. NSSO, CSO and functions. Methods of Probability and Non Probability sampling. Definition, Sampling with & without replacement (WR/WOR). Lottery method & use of Random numbers to select Simple random sample. Estimation of population mean & total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR). Estimation of population proportion and total. Expectation & Variance of the estimators, Unbiased estimator of variance of these estimators. (WR/WOR). Estimation of Sample size based on a desired accuracy in case of SRS for variables & attributes. (WR/WOR).		**15 Lectures**
UNIT II: STRATIFIED SAMPLING Need for Stratification of population. Definition of Stratified Sample. Advantages of Stratified Sampling. Estimation of population mean & total in case of Stratified Random Sampling (WOR within each strata). Expectation & Variance of the unbiased estimators, Unbiased estimators of variances of these estimators. Proportional allocation, Optimum allocation with and without varying costs. Comparison of Simple Random Sampling, Stratified Random Sampling using Proportional allocation &Neyman allocation. Estimation of population proportion & total in case of Stratified Random Sampling (WOR within each strata).		**15 Lectures**

UNIT III: RATIO & REGRESSION ESTIMATION AND SAMPLING METHODS Ratio Estimators for population Ratio, Mean & Total. Expectation & MSE of the Estimators. Estimators of MSE. Regression Estimators for population Mean & Total. Expectation & Variance of the Estimators assuming known value of regression coefficient 'b'. Estimation of 'b'. Resulting variance of the estimators. Comparison of Ratio, Regression & mean per unit estimators. Introduction to Systematic sampling, Cluster sampling & Two Stage sampling.	**15 Lectures**

SEMESTER III: PRACTICALS BASED ON PAPER II

1. Designing of Questionnaire.
2. Simple Random Sampling for Variables.
3. Simple Random Sampling for Attributes.
4. Estimation of Sample Size in Simple Random Sampling.
5. Stratified Random Sampling.
6. Ratio Estimation.
7. Regression Estimation.

REFERENCES:

1. Cochran.W.G. (1978). *Sampling Techniques,* Third Edition: WileyEastern Limited
2. Daroga Singh&F.S.Chaudhary. (1986).*Theory and Analysis of Sample Survey Design :* Wiley Eastern Ltd
3. Des Raj. (1968).*Sampling Theory*:McGraw Hill Series in Probability and Statistics.
4. Gupta S.C.&Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand& Sons
5. Mukhopadhyay P. (1998). *Theory and Methods of Survey Sampling*: Prentice Hall of India
6. Murthy M.N.(1967).*Sampling Theory and methods*:Statistical Publishing Society.
7. P.V. Sukhatme&B.V. Sukhatme. (1984). *Sampling Theory of Surveys with Applications,*Third Edition: Iowa State University Press.Pvt. Ltd.
8. Sampath S.(2005). *Sampling Theory and Methods,*Second Edition: Narosa PublishingHouse

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER IV

PAPER I

- To study normal distribution and its applications.
- To use sampling distributions in testing equality of means, independence of attributes,goodness of fit, etc.

Course Code	Title	Credits
	PROBABILITY AND SAMPLING DISTRIBUTIONS	**3 Credits**
UNIT I: STANDARD CONTINUOUS PROBABILITY DISTRIBUTIONS Rectangular, Triangular with parameters (a, b, c), Exponential,Gamma (with one & twoparameters), Beta (Types I & II). Cauchy (with one & two parameters) The following aspects of the above distributions (wherever applicable) to be discussed: Mean, Median, Mode & Standard deviation. Moment Generating Function, Additive property, Cumulant Generating Function. Skewness and Kurtosis (without proof). Fitting of Distribution. Interrelations between the distributions.		**15 Lectures**
UNIT II: NORMAL DISTRIBUTION Mean, Median, Mode, Standard deviation, Moment Generating function, Cumulant Generating function, Moments & Cumulants (up to fourth order). Recurrence relation for central moments, skewness & kurtosis, Mean absolute deviation. Distribution of linear function of independent Normal variables. Fitting of Normal Distribution. CentralLimit theorem for i.i.d. random variables. Log Normal Distribution: Mean, variance, distribution of product of independent log normal variables.		**15 Lectures**
UNIT III: EXACT SAMPLING DISTRIBUTIONS Chi-Square Distribution: Concept of degrees of freedom. Mean, Median, Mode & Standard deviation. Moment generating function, Cumulant generating function. Additive property, Distribution of the sum of squares of independent Standard Normal variables. Sampling distributions of sample mean and sample variance and their independence for a sample drawn from Normal distribution (without proof). Applications of Chi-Square: Confidence interval for the variance of a Normal population, Test of significance for specified value of variance of a Normal population. Test for goodness of fit, Test for independence of attributes, Yates' correction. t distribution: Derivation of p.d.f. of t ,Mean, Median, Mode & Standard deviation.. Asymptotic properties.Students's t, Applications of t: Confidence interval for: Mean of		**15 Lectures**

Normal population, difference between means of two independent Normal populations having the same variance. Test of significance of mean of a Normal population, difference in means of two Normal populations (based on independent samples with equal variances & dependent samples). F-distribution: Mean, Mode & Standard deviation. Distribution of Reciprocal of an F variate, Ratio of two independent Chi-squares divided by their respective degrees of freedom. Interrelationship of F with t-distribution, Chi-square distribution & Normal distribution. Applications of Confidence interval for ratio of variances of two independent Normal populations. Test for equality of variances of two independent Normal populations.	

SEMESTER III: PRACTICALS BASED ON PAPER I

1. Standard Continuous Distributions.
2. Fitting of Standard Continuous Distributions.
3. Normal Distribution
4. Fitting of Normal distribution, Central Limit Theorem.
5. Chi Square distribution.
6. t distribution.
7. F distribution.

REFERENCES:

1. Goon A.M., Gupta M.K & Dasgupta B. (2013). *An Outline of Statistical Theory*,
2. Gupta S.C.&Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand & Sons
3. Hoel P. G. (1966). *Introduction to Mathematical Statistics*, Fourth Edition : John Wiley & Sons Inc.
4. Hogg R. V.&CraigA.T.(2012). *Introduction to Mathematical Statistics*, Seventh Edition: CollierMcMillan Publishers.
5. Hogg R. V.&Tannis E. A. (1988). *Probability and Statistical Inference*, Third Edition: CollierMcMillan Publishers.

6. Kapur J. N.&SaxenaH.C.*Mathematical Statistics*, Fifteenth Edition : S. Chand & Company Ltd.
7. Medhi J. (2013). *Statistical Methods*; *An Introductory Text*, SecondEdition: Wiley Eastern Ltd.
8. Miller I., Miller M.& Freund J.E.(1999)*John E. Freund's Mathematical Statistics*, Sixth Edition:Pearson Education Inc.
9. MoodA. M., GraybillF.A., &BoyesD. C. (2001). *Introduction to the theory of Statistics,* ThirdEdition: McGraw-Hill Book Company. Vol. 1, Third Edition: The World Press Pvt. Ltd.

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER IV

PAPER II

- To design an experiment for specified objectives.
- To evaluate the data collected using ANOVA techniques.

Course Code	Title	Credits
	ANALYSIS OF VARIANCE & DESIGN OF EXPERIMENTS	**3 Credits**
UNIT I: ANALYSIS OF VARIANCE Introduction, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two-way classification with one observation per cell. Mathematical Model, Assumptions, Expectation of various sum of squares, F- test, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts.		**15 Lectures**
UNIT II: DESIGN OF EXPERIMENTS Experiment, Experimental unit, Treatment, Yield, Block, Replicate, Experimental Error, Precision. Principles of Design of Experiments: Replication, Randomization & Local Control. Efficiency of design D1 with respect to design D2. Choice of size, shape of plots & blocks in agricultural &nonagricultural experiments. Completely Randomized Design (CRD) & Randomized Block Design (RBD): Mathematical Model, Assumptions, Expectation of various sum of squares, F-test, Analysis of variance table, Advantages. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of RBD relative to a CRD. Missing plot technique for one missing observation in case of CRD and RBD.		**15 Lectures**

UNIT III: LATIN SQUARE DESIGN& FACTORIAL EXPERIMENTS:	**15 Lectures**
Latin Square Design: Mathematical Model, Assumptions, Expectation of various sum of squares, F-test, Analysis of variance table, Advantages. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard error and Confidence limits for elementary treatment contrasts. Efficiency of the design relative to RBD, CRD. Missing plot technique for one missing observation in case of LSD Factorial Experiments: Advantages. 22, 23 Experiments. Definition of Orthogonal Contrast, Calculation of Main & Interaction Effects. Yates' method. Analysis of 2^2& 2^3 factorial Experiments.	

SEMESTER III: PRACTICALS BASED ON PAPER II

1. One way Analysis of Variance.
2. Two-way Analysis of Variance.
3. Completely Randomized Design.
4. Randomized Block Design.
5. Latin Square Design.
6. Missing Observations in CRD, RBD & LSD.
7. Factorial Experiments.

REFERENCES:

1. Cochran.W.G. (1978). *Sampling Techniques,* Third Edition: WileyEastern Limited
2. Daroga Singh&F.S.Chaudhary. (1986).*Theory and Analysis of Sample Survey Design :* Wiley Eastern Ltd
3. Des Raj. (1968).*Sampling Theory*:McGraw Hill Series in Probability and Statistics.
4. Gupta S.C.&Kapoor V.K. (2007).*Fundamentals of Mathematical Statistics*: Sultan Chand& Sons
5. Mukhopadhyay P. (1998). *Theory and Methods of Survey Sampling*: Prentice Hall of India
6. Murthy M.N.(1967).*Sampling Theory and methods*:Statistical Publishing Society.
7. P.V. Sukhatme&B.V. Sukhatme. (1984). *Sampling Theory of Surveys with Applications,*Third Edition: Iowa State University Press.Pvt. Ltd.
8. Sampath S.(2005). *Sampling Theory and Methods,*Second Edition: Narosa PublishingHouse

SEMESTER III
THEORY MINOR

TITLE OF COURSE	OPERATIONS RESEARCH			
COURSE CODE	UNIT	TOPICS	LECTURES/ WEEK	CREDITS
	I	LINEAR PROGRAMMING PROBLEM	1	3
	II	TRANSPORTATION PROBLEM	1	
	III	ASSIGNMENT PROBLEM & SEQUENCING	1	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
	OPERATIONS RESEARCH I	2	1

SEMESTER IV
THEORY MINOR

TITLE OF COURSE	REGRESSION AND TIME SERIES			
COURSE CODE	**UNIT**	**TOPICS**	**LECTURES/ WEEK**	**CREDITS**
	I	**CORRELATION AND ASSOCIATION**	**1**	**3**
	II	**REGRESSION ANALYSIS**	**1**	
	III	**TIME SERIES**	**1**	

PRACTICAL

COURSE CODE	PRACTICALS BASED ON	LECTURES/ WEEK	CREDITS
	REGRESSION AND TIME SERIES	**2**	**1**

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER III

PAPER I

- To understand typical industry problems like transportation, assignment etc.
- To learn MS Excel to solve problems related to optimization.

Course Code	Title	Credits
	OPERATIONS RESEARCH	**3 Credits**
UNIT I: LINEAR PROGRAMMING PROBLEM Mathematical Formulation: Maximization & Minimization. Solution, Feasible Solution, Basic Feasible Solution, Optimal solution. Graphical Solution for problems with two variables. Simplex method of solving problems with two or more variables. Big M method. Concept of Duality. Its use in solving L.P.P. Relationship between optimum solutions of Primal and Dual.Economic interpretation of Dual.		**15 Lectures**
UNIT II: TRANSPORTATION PROBLEM Mathematical Formulation, Solution, Feasible Solution. Initial Basic FeasibleSolution by North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method. Optimal Solution by MODI Method. Optimality test,Improvement procedure. Variants in Transportation Problem: Unbalanced, Maximization, Prohibitedroute type.		**15 Lectures**
UNIT III: ASSIGNMENT PROBLEM & SEQUENCING Assignment: Mathematical Formulation. Solution by Complete Enumeration Method and Hungarian method.Variants in Assignment Problem: Unbalanced,Maximization type, Restricted (prohibited) route. Travelling Salesman Problem. Sequencing Problem: Processing n Jobs through 2 and 3 Machines & 2 Jobsthrough m Machines.		

SEMESTER III: PRACTICALS BASED ON PAPER I

1. Formulation and Graphical Solution of L.P.P.
2. Simplex Method.
3. Duality.
4. Transportation.
5. Assignment.
6. Sequencing.
7. MS Excel Solver

REFERENCES:

1. Bronson R. (1997). *Schaum Series book in Operations Research.* Second edition: Tata McGrawHill Publishing Company Ltd.
2. Kantiswaroop&Gupta M. (2010). *Operations Research,* Twelfth Edition: S Chand & Sons.
3. Sasieni M., Yaspan A.&Friedman L. (1959).*Operations Research; Methods and Problems*: JohnWiley & Sons.
4. Sharma J. K. (1989). *Mathematical Models in Operations Research*:Tata McGraw Hill PublishingCo. Ltd.
5. Sharma J.K. (2001). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
6. Sharma S.D. *Operations Research*. Eleventh Edition: KedarNath Ram Nath& Company.
7. TahaH. A.(2010). *Operations Research*. Ninth Edition: Prentice Hall of India.
8. Wagner H. M. (1970). *Principles of Operations Research with Applications to ManagementDecisions,* Second Edition : Prentice Hall of India Ltd.

SYLLABUS FOR S.Y.B.Sc. UNDER NEP SEMESTER IV

PAPER I

- To understand planning and evaluation of project.
- To acquire skills in strategy planning and decision making.

Course Code	Title	Credits
	REGRESSION AND TIME SERIES	**3 Credits**
UNIT I: CORRELATION AND ASSOCIATION Bivariate frequency distribution, marginal and conditional distribution, Scatter Diagram, Bubble chart. Product moment correlation coefficient and its properties. Spearman's Rank correlation (with and without ties). Association of attributes: Yule's coefficient of association, Yule's coefficient of colligation.		**15 Lectures**
UNIT II: REGRESSION ANALYSIS Linear regression. Fitting a straight line by method of least squares. Coefficient of determination. Relation between regression coefficients and correlation coefficient. Fitting of curves reducible to linear form by transformation. Fitting a quadratic curve by method of least squares.		**15 Lectures**
UNIT III: TIME SERIES Definition of time series and its components. Models of time series. Exponential Smoothing method. Estimation of trend by: Freehand curve, Method of semi averages, Method of Moving averages, Method of least squares (linear trend only). Merits and demerits of these methods. Estimation of seasonal component by, Method of simple averages, Ratio to moving average method. Ratio to trend method.		**15 Lectures**

SEMESTER IV: PRACTICALS BASED ON PAPER I

1. Association
2. Correlation
3. Regression I
4. Regression II
5. Time Series I
6. Time series II

REFERENCES:

9. Bronson R. (1997). *Schaum Series book in Operations Research.* Second edition: Tata McGrawHill Publishing Company Ltd.
10. Kantiswaroop&Gupta M. (2010). *Operations Research*, Twelfth Edition: S Chand & Sons.
11. Sasieni M., Yaspan A.&Friedman L. (1959).*Operations Research; Methods and Problems*: JohnWiley & Sons.
12. Sharma J. K. (1989). *Mathematical Models in Operations Research*:Tata McGraw Hill PublishingCo. Ltd.
13. Sharma J.K. (2001). *Quantitative Techniques for Managerial Decisions*: MacMillan India Ltd.
14. Sharma S.D. *Operations Research*. Eleventh Edition: KedarNath Ram Nath& Company.
15. TahaH. A.(2010). *Operations Research*. Ninth Edition: Prentice Hall of India.
16. Wagner H. M. (1970). *Principles of Operations Research with Applications to ManagementDecisions,* Second Edition : Prentice Hall of India Ltd.