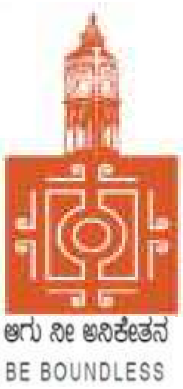


# BENGALURU CITY UNIVERSITY

**CHOICE BASED CREDIT SYSTEM**

**(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)**

## Syllabus for B.Sc. Statistics
## (V & VI Semester)

**2023-24 onwards**

**BENGALURU CENTRAL UNIVERSITY**
**BOARD OF STUDIES IN STATISTICS**

Date:13-09-2023

**Proceedings of the meeting of the Board of Studies in Statistics (UG) held at 3.00 pm on 13-09-2023 in the Department of Statistics , Jnana Bharathi Campus, Bangalore university, Bangalore.**

The meeting started with welcome of the members by the Chairperson of the board of studies. The following decisions were taken.

1. The members discussed and approved the syllabus for V and VI semesters of UG optional Statistics as per KSHEC guidelines.
2. The panel of examiners for B Sc examinations for the year 2023-24 is approved.

Members Present:

1. Mr. Prakash, R. Associate Professor, Vijaya College, Bengaluru — R. Prakash 13/9/23
2. Narayana Gowda, N., Reva University, Bengaluru
3. Dr. Raveendra Naika, T., Associate Professor, Maharani Cluster University, Bengaluru
4. Dr. S. K. Lakshmi, Mount Carmel College, Bengaluru — 13/09/23
5. Smt. Ambika, C., Mount Carmel College, Bengaluru — 13.09.2023
6. Prof. Parameshwar V Pandit (Chairperson), Department of Statistics, Bangalore University, Bengaluru — 13/9/2023

Dr. Parameshwar V. Pandit
Professor and Chairperson
Department of Statistics
Bangalore University

**BENGALURU CITY UNIVERSITY**

**Regulations and Syllabus for STATISTICS**

**in**

**B.Sc. and B.Sc. (Honours) Course (NEP 2020)**

# Preamble

Several reforms in our education system has been proposed and developed by Ministry of HRD as National Education Policy (NEP)2020 which includes broad based multidisciplinary undergraduate education with necessary knowledge, skills and competencies. It also proposes to bring equity, efficiency and academic excellence at different levels of education. NEP also recommended multidisciplinary undergraduate programmes with multiple exit and multiple entry options with the provision of Certificate/Diploma/Degrees at each of the exits.

Probability and Statistics is the language of uncertainties, riddled modern information age. Statistics facilitates the decision making process by quantifying the element of chance or uncertainties. Its descriptive and inferential procedures not only formulate the basis of the growth of almost all disciplines of the contemporary world, and also provide an array of employment avenues in all fields. This is a rigorous program in Probability Theory, Statistical Inference, Multivariate Analysis, Linear Models and Regression Analysis and Sample surveys and Design of Experiments designed to give a sound foundation in fundamentals and training in practical Statistics leading to statistical data analysis.

The eight semester 176 credit program has a variety of elective courses to choose from including enough courses on statistical software. A person successfully completing the program will have enough knowledge and expertise to statistically analyze small and large univariate and multivariate data sets, pursue advanced courses in Statistics or a Ph.D. in Statistics, work in software/data analytics industry as domain expert, independently consult for statistical data analysis.

In this direction, the Board Studies in Statistics (PG&UG) approved the syllabus along with structure and schemes for BSc, BSc (Honours) and MSc programmes. The Board of Studies consists of experts as below:

| Program Name | **BSc in STATISTICS** | Semester | **V** |
|---|---|---|---|
| Course Title | **Sampling Theory and Regression analysis (Theory)** | | |
| Course Code: | **STAC9-T** | No. of Credits | **04** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours 30 min** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Outcomes (COs)**: After the successful completion of the course, the student will be able to:

CO1.Understand the principles underlying sampling as a means of making inferences about a population.

CO2.Understand different sampling techniques.

CO3. To learn to estimate population parameters from a sample.

CO4. Develop and understanding of simple and multiple regression models, including the assumptions underlying these models, techniques for inference and hypothesis testing and diagnostics checks and corrections.

CO5. Apply regression analysis techniques to real world data sets.

| **Contents** | **60 Hrs** |
|---|---|
| **Unit 1: Introduction to sampling** | 15 Hrs |
| Objectives and principles of sampling theory; Concept of population and sample; complete enumeration versus sampling; Planning, execution, construction of questionnaire and analysis of a sample survey; basic principle of sample survey; sampling and non-sampling errors. Probability sampling and nonprobability sampling, Judgement sampling, quota sampling, snowball sampling, convenience sampling. | |
| **Unit 2: Simple random sampling (SRS)** | 15 Hrs |
| Sampling with and without replacement. Unbiased estimators of population mean and total. Derivation of sampling variances. SRS for proportions. Derivation of the sampling variances andstandard errors. Confidence limits. Determination of sample size. Advantages and limitations of SRS | |
| **Unit 3: Stratified sampling and systematic sampling** | 15 Hrs |
| Stratified random sampling: Need for stratification, advantages, and limitations. Unbiased estimators of population mean and total. Derivation of the variance of the estimators and their estimation. Proportional, optimum and Neyman allocations. Comparison of variances with SRSWOR. Estimation of gain in precision due to stratification.<br>Linear systematic sampling, its advantages and limitations. Estimation of mean, total and variance of the estimators. Comparison with SRSWOR .Circular systematic sampling. | |

| | |
|---|---|
| **Unit 4: Simple linear regression** | 15 Hrs |
| Assumptions, inference related to regression parameters, standard error of prediction, tests on intercepts and slopes, extrapolation, diagnostic checks and correction: graphical techniques, tests for normality, uncorrelatedness, homoscedasticity, lack-of-fit testing, transformations on Y or X (Box-Cox, square root, log etc.), method of weighted least squares, inverse regression. | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **Program Outcomes (POs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| CO1.Understand the principles underlying sampling as a means of making inferences about a population. | x | x | x | x | | | | | x | x | | |
| CO2.Understand the difference between probability and nonprobability sampling. | x | x | x | x | | | | | x | x | | |
| CO3. Understand different sampling techniques. | x | x | x | x | | | | | x | x | | |
| CO5. Apply regression analysis techniques to real word data sets | | | | x | x | | | | | | | |

## Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 15 |
| Internal Test 2 | 15 |
| Assignment/Seminar (5 marks)+Attendance(5 marks) | 10 |
| **Total** | **40 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

## *Practical*

| Course Title | **Sampling theory and Regression analysis (Practical)** | Practical Credits | **2** |
|---|---|---|---|
| Course Code | **STAC10-P** | Contact Hours | **60 Hours** |
| Formative Assessment | **25 Marks** | Summative Assessment | **25 Marks** |

**Practical Content**

1. Drawing of random sample under SRSWR from a given population and estimation of the mean and total and the standard errors of the estimators. Construction of confidence intervals.
2. Drawing of random sample under SRSWOR from a given population and estimation of the mean and total and the standard errors of the estimators. Construction of confidence intervals.
3. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR. Construction of confidence intervals.
4. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWOR. Construction of confidence intervals.
5. Estimation of the mean, total and the standard error of the estimator under stratified random sampling. Construction of confidence intervals.
6. Exercise on allocation of samples in Stratified sampling. (Proportional Allocation)
7. Exercise on allocation of samples in Stratified sampling. (Neyman Allocation)
8. Systematic sampling-1
9. Systematic sampling-2
10. Simple Linear Regression

**Pedagogy:** Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

| **Formative Assessment for Practical** | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 10 |
| Internal Test 2 | 10 |
| Attendance | 5 |
| **Total** | **25 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

| References | |
|---|---|
| 1 | Cochran, W. G. (2007): Sampling Techniques, Third Edition, Wiley India Pvt. Ltd., New Delhi. |
| 2 | Changbao Wu and Mary E. Thompson (2020): Sampling Theory and Practice, Springer Nature Switzerland. |
| 3 | Raghunath Arnab (2017): Survey Sampling Theory and applications (2017), Elsevier |
| 4 | Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House. |
| 5 | Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press |
| 6 | Murthy, M. N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Kolkata. |
| 7 | Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi |
| 8 | Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall |
| 9 | Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi. |
| 10 | Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi. |
| 11 | Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi. |
| 12 | Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003). Introduction to Linear Regression Analysis, Wiley. |
| 13 | Weisberg, S. (2005). Applied Liner Regression, Wiley. |
| 14 | Yan, X. and Su, X. G. (2009). Linear Regression Analysis: Theory & Computing, World Scientific. |

| Program Name | **BSc in STATISTICS** | Semester | **V** |
|---|---|---|---|
| Course Title | **Statistical Quality Control and Statistical Inference -II (Theory)** | | |
| Course Code: | **STAC14-T** | No. of Credits | **04** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours 30 min** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Outcomes (COs)**: After the successful completion of the course, the student will be able to:

CO1. Learn about process control and product control, different limits and causes of variation.

CO2. Understand control chart for variables and process capability.

CO3. Understand lot acceptance sampling and sampling plans.

CO4: Learn about UMP test, MLR property and Likelihood ratio tests.

CO5: Learn about one sample and two sample nonparametric tests.

| **Contents** | **60 Hrs** |
|---|---|
| **Unit-1: Process Control** | 15 Hrs |
| Introduction – Statistical Quality Control (SQC) - Aims and objectives, Chance and assignable causes of variation, Process control and product control. Control charts and basis for its construction, Action, and warning limits. Various tools of SQC. Rational subgroups, Criteria for detecting lack of control. Control charts for variables: Derivation of control limits, basis, construction and interpretation of mean, range and standard deviation charts, np-chart, p-chart, stabilized p-chart c-chart and u-chart. | |
| **Unit-2: Process Capability and Product control** | 15 Hrs |
| Process capability study: Natural tolerance limits and specification limits, process capability, PCR and interpretation.<br>Lot Acceptance Sampling – Sampling Inspection,100 % inspection and rectifying inspection AQL, LTPD, Producer's Risk and Consumer's Risk. Acceptance sampling plans – single sampling plan by attributes. Derivation of OC, AOQ, ASN, and ATI functions for single sampling plan. | |
| **Unit-3: Testing of Hypothesis-II** | 15 Hrs |
| Definition of UMP test, monotone likelihood ratio (MLR) property, Examples of distributions having MLR property, Construction of UMP test using MLR property. UMP test for single parameter exponential family of distributions. Likelihood ratio (LR)tests, LR test for normal, exponential. | |

| **Unit-4: Nonparametric tests** | 15 Hrs |
|---|---|
| Nonparametric and distribution-free tests, one sample problems: Sign test, Wilcoxon signed rank test, Kolmogorov-Smirnov test. Test of randomness using run test.<br>General two sample problems: Wolfowitz runs test, Kolmogorov Smirnov two sample test (for sample of equal size), Median test, Wilcoxon-Mann-Whitney U-test. Several sample problems: Friedman's test, Kruskal Wallis test. (Based on large sample approximations). | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **Program Outcomes (POs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| CO1: Learn about process control and product control, different limits and causes of variation. | x | x | x | x | | | | | x | x | | |
| CO2: Understand control chart for variables and process capability. | x | x | x | x | | | | | x | x | | |
| CO3: Understand lot acceptance sampling and sampling plans. | x | x | x | x | | | | | x | x | | |
| CO4. Learn about UMP test, MLR property and Likelihood ratio tests. | x | x | x | x | | | | | x | x | | |
| CO5. Learn about one sample and two sample nonparametric tests. | x | x | x | x | | | | | x | x | | |

## Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 15 |
| Internal Test 2 | 15 |
| Assignment/Seminar (5 marks)+Attendance(5marks) | 10 |
| **Total** | **40 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

| Course Title | **Statistical Quality Control and Statistical Inference -II (Practicals)** | Practical Credits | **2** |
|---|---|---|---|
| Course Code | **STAC15-P** | Contact Hours | **60 Hours** |
| Formative Assessment | **25 Marks** | Summative Assessment | **25 Marks** |

**Practical Content**

1. $\bar{x}$-R charts (Standard values known and unknown).
2. $\bar{x}$-S charts (Standard values known and unknown).
3. np and p charts (Standard values known and unknown).
4. C and u charts (Standard values known and unknown).
5. Drawing OC, AOQ, ASN, and ATI curves for single sampling plan.
6. UMP test based on sample from Bernoulli and Poisson distributions.
7. UMP test based on sample from Normal distribution.
8. UMP test based on sample from exponential distribution.
9. One sample Nonparametric tests: Kolmogorov-Smirnov test, sign test, Wilcoxon signed rank test,
10. Two sample Nonparametric tests: Mann-Whitney (Wilcoxon rank sum test), Wald-Wolfowitz Run test,

**References**


| | |
|---|---|
| 1 | George Casella, Roger L. Berger (2020): Statistical Inference, 2nd ed., Thomson Learning. |
| 2 | Rohatagi, V.K.: (2010): Statistical Inference, Wiley Eastern, New Delhi. |
| 3 | Hogg Mckean and Craig (2009): Introduction to Mathematical Statistics, 6th edition, Pearson Prentice Hall. |
| 4 | Goon, A. M. , Gupta, M. K. , Das Gupta, B. (1991). Fundamentals Of Statistics, Vol.I (World Press, Calcutta). |
| 5 | Grant, E. L. and Leavenworth, R. S. (1996): Statistical Quality Control. 7th Edition, Mc Grawhill, New York. |
| 6 | Mahajan, M. (2001): Statistical Quality Control, Dhanpat Rai & Co. (P) Ltd. New Delhi. |
| 7 | Gupta, R. C: Statistical Quality Control (Khanna Pub, Co.) |
| 8 | Montgomery, D .C (2013): Introduction to Statistical Quality Control (Wiley Int.Edn) |
| 9 | Gupta, R. C and V. K. Kapoor: Fundamentals of Applied Statistics, (Sultan Chand and Co.) |

| | | | |
|---|---|---|---|
| Program Name | **BSc in STATISTICS** | Semester | **VI** |
| Course Title | **Analysis of variance and Design of experiments (Theory)** | | |
| Course Code: | **STAC11-T** | No. of Credits | **4** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours 30 min** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Outcomes (COs)**:

After the successful completion of the course, the student will be able to:

CO1. Learn fixed and random effect models and one-way and two-way classified data.

CO2.Understand different designs (CRD, RBD, LSD) and missing plot techniques.

CO3. Understand the different factorial experiments.

CO4. Develop complete and partial confounding for factorial experiments.

| **CONTENTS** | **60 Hrs** |
|---|---|
| **UNIT 1: ANALYSIS OF VARIANCE** | 15 Hrs |
| Meaning and assumptions. Fixed and random effect models. Analysis of One -way and two way classified data with and without interaction effects. Multiple comparison tests: Tukey's method, Critical difference. | |
| **UNIT 2: EXPERIMENTAL DESIGNS** | 15 Hrs |
| Principles of design of experiments. Completely randomized, randomized block and Latin square designs (CRD, RBD, LSD) – layout formation and the analysis using fixed effect models. Comparison of efficiencies of CRD, RBD and LSD. Estimation of a missing observation in RBD and LSD and its analysis. | |
| **UNIT 3: INCOMPLETE BLOCK DESIGNS AND FACTORIAL EXPERIMENTS** | 15 Hrs |
| Introduction to incomplete block designs, BIBD and its analysis, Yuden square designs, Basic concepts – main and interaction effects, and orthogonal contrasts in $2^2$ and $2^3$ factorial experiments. Yates' method of computing factorial effects total. | |
| **UNIT 4: ANALYSIS OF FACTORIAL EXPERIMENTS AND CONFOUNDING** | 15 Hrs |
| Analysis of $2^2$and $2^3$factorial experiments in RBD, Need for confounding. Types of confounding - Complete and partial, Confounding in a $2^3$ - factorial experiment in RBD and its analysis. | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)**

| Course Outcomes (COs) / Program Outcomes (POs) | Program Outcomes (POs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| CO1.Learn about fixed, random, and mixed effect models and one-way and two-way classified data. | x | x | | x | | x | | | x | x | | |
| CO2.Understand different designs (CRD, RBD, LSD) and missing plot techniques. | x | x | | | | x | | | x | x | | |
| CO3. Understand the different factorial experiments. | x | x | | | | x | | | x | x | | |
| CO4. Develop complete and partial confounding for factorial experiments. | x | x | | x | | x | | | x | x | | |

## Pedagogy:

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 15 |
| Internal Test 2 | 15 |
| Assignment/Seminar (5 marks)+Attendance(5marks) | 10 |
| **Total** | **40 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

**Practicals:**

| Course Title | **Analysis of variance and Design of experiments (Practicals)** | Practical Credits | **2** |
|---|---|---|---|
| Course Code | **STAC12-P** | Contact Hours | **60 Hours** |
| Formative Assessment | **25 Marks** | Summative Assessment | **25 Marks** |

**Practical Content**

1. ANOVA for one-way classified data.
2. ANOVA for two-way classified data (without interaction).
3. Analysis of CRD.
4. Analysis of RBD.
5. Analysis of LSD.
6. Missing plot techniques in RBD and LSD.
7. Analysis of $2^2$factorial experiment usingRBD layout.
8. Analysis of $2^3$factorial experiment using RBD layout.
9. Analysis of $2^3$factorial experiment using RBD layout (Complete confounding).
10. Analysis of $2^3$factorial experiment using RBD layout (Partial confounding).

**Pedagogy:** Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

| **Formative Assessment for Practical** | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 10 |
| Internal Test 2 | 10 |
| Attendance | 5 |
| **Total** | **25 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |


| **References** | |
|---|---|
| 1 | Goon, A. M., Gupta, M. K., Das Gupta, B.(1991). Fundamentals of Statistics, Vol-I, World Press, Calcutta. |
| 2 | Montgomery. D. C. (2014): Design and Analysis of Experiments, Wiley. New York. |
| 3 | Joshi. D. D. (1987): Linear Estimation and Design of Experiments, New Age International (P) Limited, New Delhi. |
| 4 | Cochran. G and G. M. Cox, G. M. (1992): Experimental Designs, John Wiley and Sons, New York. |

| References | |
|---|---|
| 5 | Mukhopadhyay. P (2015): Applied Statistics, Books and Allied (P) Ltd., Kolkata. |

| Program Name | **BSc in STATISTICS** | Semester | **VI** |
|---|---|---|---|
| Course Title | **Applied Statistics(Theory)** | | |
| Course Code: | **STAC16-T** | No. of Credits | **04** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours 30 min** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Outcomes (COs)**: After the successful completion of the course, the student will be able to:

CO1. formulation of a linear programming problem and solve it using graphical, simplex methods. Conceptualize the feasible region

CO2. find out feasible solution and transportation and assignment problems and give the optimal solution and solve game theory problems

CO3.Understand the Price and Quantity Index numbers and their different measures, understand the applicability of cost-of-living Index number.

CO4. Know the components and Need for Time series, understand the different methods of studying trend and Seasonal Index.

CO5.Study the concept of vital statistics, sources of data, different measures of Fertility and Mortality, Understand the Growth rates- GRR and NRR and their interpretations.

| **Contents** | **60 Hrs** |
|---|---|
| **Unit 1: Introduction to operations research(OR) and Linear programming problem(LPP)** | 15 Hrs |
| Definition and scope of operations research (OR). Linear programming problem (LPP): Definition-standard forms. Formulation of LPP. Basic feasible solutions, degenerate and non-degenerate solutions. Graphical solution and simplex algorithm for solving an LPP., Criteria for unbounded, multiple, and infeasible solutions. Concept of duality. | |
| **Unit -2: Transportation problem, Assignment Problem and Game theory** | 15 Hrs |
| **Transportation problem**: Mathematical formulation of transportation problem. Existence of feasible solution. Finding initial basic feasible solution: North - West corner rule and Vogel's method. .<br>**Assignment problem**: Mathematical formulation of assignment problem and Hungarian algorithm.<br>**Game theory**: Basic concepts. Two – Person Zero Sum Game. Pure and Mixed Strategies. Maximin – Minimax principle, Games with saddle point. Principle of dominance. Games without saddle Point . Mixed Strategies. Solution for a (2x2) Game by algebraic method. Solution by graphical method for (2 x n) and (m x 2) games . | |

| Unit -3: Index numbers and Time series | 15 Hrs |
|---|---|
| **Index numbers:** Introduction. Price and quantity index numbers. Construction of index numbers: Simple and weighted methods. Problems involved in the construction of general index numbers. Tests for consistency of index numbers, Consumer price index. Problems involved in the construction of Consumer price index numbers. Uses and limitations.<br>**Time series**: Components of Time Series. Additive and multiplicative models. Measurement of trend by moving averages and by least squares. Construction of seasonal indices by simple averages and ratio to moving averages. | |
| **Unit 4: Demography (Vital Statistics)** | 15 Hrs |
| Sources of demographic data. Measurement of Mortality: Crude, age-specific and standardized death rates. Infant mortality rate, maternal mortality rate. Measurement of fertility: Crude, age specific, general, and total fertility rates. Reproduction rates.<br>Life table: Components of a life table, force of morality and expectation of life. Construction of a life table. Uses of a life table. | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)**

| Course Outcomes (COs) / Program Outcomes (POs) | Program Outcomes (POs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| CO1. Formulate a linear programming problem and solve it using graphical, simplex methods. Conceptualize the feasible region. | x | x | x | x | | | | | x | x | | |
| CO2.To find out feasible solution and transportation and assignment problems and give the optimal solution, solving game theory problems | x | x | x | x | | | | | x | x | | |
| CO3. Understand the Price and Quantity Index numbers and their different measures, understand the applicability of cost-of-living Index number. | x | x | x | x | | | | | x | x | | |
| CO4. Know the components and Need for Time series, understand the different methods of studying trend and Seasonal Index. | x | x | x | x | | | | | x | x | | |
| CO5.Study the concept of vital statistics, sources of data, different measures of Fertility and Mortality, Understand the Growth rates- GRR and NRR and their interpretations. | x | x | x | x | | | | | x | x | | |

## Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 15 |
| Internal Test 2 | 15 |
| Assignment/Seminar (5 marks)+Attendance(5marks) | 10 |
| **Total** | **40 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

| Course Title | **Applied Statistics(Practicals)** | | Practical Credits | **2** |
|---|---|---|---|---|
| Course Code | **STAC17-P** | | Contact Hours | **60 Hours** |
| Formative Assessment | **25 Marks** | Summative Assessment | | **25 Marks** |
| **Practical Content** | | | | |

1. Formulation of Linear Programming Problem (L.P.P)-Graphical Solution.
2. Solution of L.P.P; Simplex Algorithm.
3. Transportation Problem
4. Assignment problem.
5. Game theory problems.
6. Construction of index numbers and consumer price index numbers, consistency of index numbers.
7. Time Series-1: Measurement of trend
8. Time Series-2: Measurement of seasonal variation
9. Vital Statistics -1: Computation of various morality and fertility rates.
10. Vital Statistics -2: Life table construction and computation of reproduction rates.

**Pedagogy:** Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

| Formative Assessment for Practical | |
|---|---|
| **Assessment Occasion/ type** | **Marks** |
| Internal Test 1 | 10 |
| Internal Test 2 | 10 |
| Attendance | 5 |
| **Total** | **25 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

| References | |
|---|---|
| 1 | Churchman, C.W, Ackoff, R.L., and Arnoff, E.L. (1957). Introduction to Operations Research, John Wiley and Sons, New York. |
| 2 | Kanthi Swaroop, Manmohan, and P.K. Gupta (2012). Operations Research, Sultan Chand, New Delhi. |
| 3 | Kalavathy, S. (2004). Operations Research, Vikas Publishing House Pvt. Ltd. New Delhi. |
| 4 | Shenoy, G.V., Srivastava, U. K., and Sharma, S.C. (2009). Operations Research for Management, 2/e, New Age International, New Delhi. |
| 5 | Mustafi, C.K. (2006). Operations Research: Methods and Practice, 3/e, New Age International, New Delhi. |
| 6 | Mital, K.V. and Mohan, C. (2004). Optimization Methods, 3/e, New Age International, New Delhi. |
| 7 | Narag, A. S. (1970). Linear Programming and Decision Making, S. Chand, New Delhi. |
| 8 | Hillier, F.S. and Leiberman, G. J. (1962). Introduction to Operations Research, Holden Day, NewYork. |
| 9 | Taha, H.A. (2010). Operational Research: An Introduction, Macmillan, New York. |
| 10 | Goon A. M., Gupta, M. K., Das Gupta, B.(1991). Fundamentals of Statistics, Vol – II, (World Press, Calcutta). |
| 11 | Monotgomery, D. C. and Runger, G. C.(2013). Applied Statistics and Probability for Engineers, Wiley India, New Delhi. |
| 12 | Saluja M. R. (1972). Indian Official Statistical Systems, Statistical Publishing Society, Calcutta. |
| 13 | SundarRao P. S. S. and Richard, J.(2012). Introduction to Biostatistics and Research Methods, 5/e, Prentice Hall of India, New Delhi. |
| 14 | CSO (1980): National Accounts Statistics – Sources and Health, Govt. of India, New Delhi. |
| 15 | UNESCO: Principles for Vital Statistics Systems, Series M – 12. |
| 16 | Sen. A. (1997): Poverty and Inequality, Stanford University Press, USA. |
| 17 | Mukhopadhyay. P (2015). Applied Statistics, Books and Allied Pvt Ltd., Kolkata. |