**Year-2023-2024**
**Syllabus of B.Sc./B.A. Programme: [Subject Name: Statistics]**
**In accordance with NEP-2020**

| Year | Semester | Course Code | Title of Paper | Theory/ Practical | Credit | Min. Marks | Max. Marks |
|---|---|---|---|---|---|---|---|
| **1st Year** | **I** | UGSTAT -101 (N) | Statistical Methods | Theory | 2 | 36 | 100 |
| | | UGSTAT -101 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| | **II** | UGSTAT -102 (N) | Probability, Distribution and Statistical Inference | Theory | 2 | 36 | 100 |
| | | UGSTAT -102 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| **2nd Year** | **III** | UGSTAT -103 (N) | Sampling Theory and Design of Experiments | Theory | 2 | 36 | 100 |
| | | UGSTAT -103 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| | **IV** | UGSTAT -104(N) | Applied Statistics | Theory | 2 | 36 | 100 |
| | | UGSTAT -104 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| **3rd Year** | **V** | **Discipline Centric Elective Course** | | | | | |
| | | DECSTAT -105 (N) | Advance Statistical Inference | Theory | 2 | 36 | 100 |
| | | DECSTAT -106 (N) | Basic Knowledge of Statistical Softwares | Theory | 2 | 36 | 100 |
| | | DECSTAT -107 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| | **VI** | **Discipline Centric Elective Course** | | | | | |
| | | DECSTAT -108 (N) | Official Statistics | Theory | 2 | 36 | 100 |
| | | DECSTAT -109 (N) | Operation Research | Theory | 2 | 36 | 100 |
| | | DECSTAT -110 (NP) | Practical and Viva voce | Practical | 2 | 36 | 100 |
| | | **Skill Enhancement Course** | | | | | |
| | | SBSSTAT-04 (N) | Numerical Methods & Basic Computer Knowledge | Theory | 4 | 36 | 100 |
| | | | **Total Credit** | | **32** | **540** | **1500** |

# Syllabus

## of

## B. Sc. (Statistics) / B. A. (Statistics)

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|---|---|---|
| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
| **Programme:** B.Sc./B.A. | **Year:**I | **Semester:**I |
| **Subject:** Statistics | | |
| **Course Code:** *UGSTAT -101 N* | **Course Title:***Statistical Methods* | |
| **CO:** To summarize the data and to obtain its salient features from the vast mass of original data.  To understand the concept of attributes. To understand and analyze and also interpret the data through graphical and diagrammatical representation of the data. Acquainting the Learner with various statistical methods.  To introduce students to different measurement scales, qualitative and quantitative and discrete and continuous data.  To help learner to organize data into frequency distribution graphs, including bar graphs, histograms, polygons, and Ogives.  Students should be able to understand the purpose for measuring central tendency, variation, skewness and kurtosis and should be able to compute them as well. Learners should be able to understand and compute various statistical measures of correlation, fitting of curve and regression, theory of Attributes. | | |
| **Course Outcomes:**<br>**CO1:**Learner will be able to understand about the concept of data collection, tabulation and also about its graphical and diagrammatical representation.<br>**CO 2:**This course provides the knowledge about all measures of central tendency and measures of dispersion with its merits, demerits and further applications<br>**CO 3:**Learner will gain sufficient knowledge about moments, skewness and kurtosis.<br>**CO 4:** Lerner will able to handle data with use of raw moments for ungrouped data, raw moments for grouped data, Central moments, Interrelationship between various moments, effect of change of origin and scale on moments, Charlier's checks, Sheppard"s correction for moments Factorial moments.<br>**CO 5:** Learner should persist knowledge of correlation, inter and intra class correlation and regression<br>**CO 6:** For the qualitative analysis, learner will able to understand theory of attributes and dichotomous classifications and measures of association. | | |
| **Credits:** 2 | | **Type of Course:** Core |
| **Max. Marks:**100 | **Min. Passing Marks:**36 | |

| Block 1 | **Data Collection and Its Representation** |
|---|---|
| Unit I | **Data Collection and Tabulation :** Meanings, Definitions and Applications of Statistics, Measurements and Scale, Measurements of qualitative data, Methods of data collection, Types of data. |
| Unit II | **Representation of Data- I (Diagrammatical representation):**  Frequency distribution, Tabulation of data, Diagrammatical Representation of data, Bar diagram, Multiple bar diagram, Divided bar diagram, Percentage bar diagram, Pie chart, Pictogram, leaf chart, |
| Unit III | **Representation of Data- I (Graphical representation):**  Graphical representation of frequency distribution, Histogram, Frequency polygon, Frequency curve, Ogive. |
| Block 2 | **Measures of Central Tendency and Dispersion** |
| Unit IV | **Measures of Central Tendency:** Types of measures of central tendency, Arithmetic mean, Fundamental Theorems on Arithmetic mean, Geometric mean, Harmonic mean, Median, Mode, Percentiles, Deciles, and Quartiles. |
| Unit V | **Measures of Dispersion :**Types of measures of Dispersion, Range, Mean Deviation, Variance and Standard deviation, Effect of change of origin and scale, Relationship between measures of central tendency and measures of dispersion, Coefficient of variation. |
| Block 3 | **Moments, Skewness and Kurtosis** |

| Unit VI | **Moments, Raw Moments and Central Moments :** Definition of moments, raw moments for ungrouped data, raw moments for grouped data, Central moments, Factorial moments, Interrelationship between various moments, effect of change of origin and scale on moments, Charlier's checks, Sheppard''s correction for moments. |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit VII | **Skewness and Kurtosis:** Definition of skewness, Measures of skewness, Pearson's coefficient, Bowley's coefficients, Kurtosis, Measures of Kurtosis, effect of change of origin and scale. |
| **Block 4** | **Correlation and Regression** |
| Unit VIII | **Bivariate Data and Correlation:** Scatter Diagram, Karl Pearson's coefficient of correlation, Properties of correlation coefficient, limits of correlation coefficient, Effect of change of origin and scale on correlation coefficient. |
| Unit IX | **Regression:** Regressions, linear regression model, principal of least square, Regression lines, Regression coefficient, Properties of Regression coefficients. |
| Unit X | **Correlation and Intra Class Correlation:** Rank correlation coefficient, Spearman's rank correlation coefficients, rank correlation coefficient for tied ranks, Intra-class correlation, some remarks on Intra-class correlation. |
| Unit XI | **Theory of Attributes:** Combinations, Classes and Class frequencies of Attributes, Dichotomous Classification, Consistency of data, joint distribution of attributes, Contingency tables, Independence and Association of Attributes, Measures of Association, Yates Correction. |

## Suggested Text Book Readings:

- Bhat B.R, Srivenkatramana T and Rao Madhava K.S.(1996): Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
- Croxton F.E, Cowden D.J and Kelin S (1973): Applied General Statistics, Prentice Hall of India.
- Goon A.M., Gupta M.K., Das Gupta. B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.
- Anderson T.W and Sclove S.L (1978) An Introduction to the Statistical Analysis of Data, Houghton Miffin\Co.
- Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill
- Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University, Press.
- Spiegel, M. R. (1967): Theory & Problems of Statistics, Schaum's Publishing Series.
- Gupta S. C. and Kapoor V. K. (1999): Fundamentals of Mathematical Statistics, , S. Chand Publication, Delhi

**This course can be opted as an elective by the students of following subjects:**
U.G/P.G. in Mathematics, Data Science, Computer Science, Agricultural Sciences, all Life Sciences and Social Sciences subjects students etc.

**Suggested equivalent online courses (MOOCs) for credit transfer:** NA

**Learner can join this for their own knowledge:** https://*onlinecourses*.nptel.ac.in/noc, Regression Analysis, Prof. Soumen Maity

**Electronic media and other digital components in the curriculum:**
**Choose any one or more than one:** (Electronic Media: Audio/Video Lectures, Online Counselling/Virtual Classes/E-Contents/e-SLM/OER/supplementary links for reference/Video Conferencing/Radio broadcast/Web Conferencing/ Other electronic and digital contents**)**

| S. No. | Course Code | Title | Uploaded Date & link |
|--------|-------------|-------|----------------------|
| 1. | UGSTAT – 101 | Correlation Analysis | uploaded on *25.09.2020*, *https://youtu.be/G4U98nAh78c* |

| 2. | UGSTAT – 101 Block – IV, Unit – X (Module – 3) | Statistical Methods, Correlation and Regression (Two Variables and Association),Rank Correlation and Intra Class Correlation | uploaded on *05.09.2020*, *https://youtu.be/L1RLSOjjORs* |
|---|---|---|---|
| 3. | UGSTAT – 101 Block – IV, Unit – IX (Module – 2) | Statistical Methods, Correlation and Regression (Two Variables and Association), Regression Analysis | uploaded on *27.08.2020*, *https://youtu.be/s9z9yHhITVE* |
| 4. | UGSTAT – 101 Block – IV, Unit – VIII (Module – 1) | Statistical Methods, Correlation and Regression (Two Variables and Association), Bivariate Data and Correlation | uploaded on *26.08.2020*, *https://youtu.be/1Bsi3YW3ySo* |
| 5. | UGSTAT – 01 Block – III | Statistical Methods, Moments, Skewness and Kurtosis | uploaded on *18.06.2019*, *https://youtu.be/SNAZ8U2Mhjl* |
| 6. | UGSTAT – 01 Block – II, Unit – II | Statistical Methods, Measures of Central Tendency and Dispersion,Measures of Dispersion | uploaded on *11.06.2019*, *https://youtu.be/E1c9t8kXJOQ* |
| 7. | UGSTAT – 01 Block – II, Unit – I | Statistical Methods, Measures of Central Tendency and Dispersion, Measures of Central Tendency | uploaded on *05.01.2019*, *https://youtu.be/JIPZjEyiLA* |
| 8. | UGSTAT – 01 Block – I | Statistical Methods, Data Collection and Its Representation | uploaded on *05.01.2019*, *https://youtu.be/JwKFj74qICQ* |

| Course prerequisites: For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** I | **Semester:** I |
| **Subject:** Statistics | | |
| **Course Code:** *UGSTAT-101NP* | **Course Title:** *Practical and Viva voce* | |
| **Course Objectives:** The main objective of this course is to develop askill to: understand the practical methods and tests related to estimation of real-life data. | | |
| **Course Outcomes:**<br>**CO1:** Learner should able to solve the numerical problems related with measures of central tendency.<br>**CO2:** Learner should able to solve the numerical problems related with measures of dispersion.<br>**CO3:** Learner should able to solve the numerical problems related with skewness and kurtosis.<br>**CO4:** Learner should able to solvethe numerical problems related with correlation and regression. | | |
| **Credits:** 2 | **Type of Course:** Core | |
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 | |
| *Practical based on UGSTAT-101N* | | |

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| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

| Programme: B.Sc./B.A. | Year: I | Semester: II |
|---|---|---|

**Subject:** Statistics

| Course Code: *UGSTAT -102 (N)* | Course Title: *Probability, Distribution and Statistical Inference* |
|---|---|

**Course Objectives:** To understand the concept of random variables, probability distributions and expectation. Understanding probability theory at basic and advance level, random variables and also their convergences at weak and strong levels. Different probability distribution (discrete and continuous). Learner will also gain the knowledge about small sample test, large sample test as well as non parametric tests.

**Course Outcomes:**

**CO1:** Learner will able to understand the concept of random experiment, random variables, probability, conditional probability and also Baye's Theorem.

**CO2:** Under this course, learner gain knowledge about the basics of probability distributions, expectations, inequalities for moments, moment generating functions etc.

**CO3:** This course gives the complete knowledge about discrete distributions and their properties and also the limiting case, relation between the discrete distributions and also fitting of distribution.

**CO4:** This course gives the complete knowledge about continuous distributions and their properties and also the limiting case, relation between them and also the lack of memory property, area property.

**CO5:** In this course, learner will have the knowledge of the inferential statistics in which they able to understand about estimation, procedure of estimation, properties of estimators and also the properties of good estimators and also knowledge about the Fisher's transformations.

**CO6:** This course also provide the knowledge of testing of hypothesis, critical region, types of errors, test of significance; which helps for making the scientific and statistical decisions.

**CO7:** This course gives knowledge about large sample test, parametric and nonparametric tests

| Credits: 2 | Type of Course: Core |
|---|---|

| Max. Marks: 100 | Min. Passing Marks: 36 |
|---|---|

| Block 1 | **Probability Theory** |
|---|---|
| Unit I | **Random experiments and Probability:** Deterministic and random experiments, Sample space, Events, Algebra of Events, Axiomatic definition of Probability, Classical definition of Probability, Statistical definition of probability, Addition Theorem of Probability |
| Unit II | **Conditional Probability:** Conditional probability, Multiplicative theorem of Probability, Independent events, Partition of sample space, Baye's Theorem. |
| **Block 2** | **Probability Distributions and Expectations** |
| Unit III | **Random Variables and Probability Distributions:** Definition and types of random variable, Cumulative distribution function and its properties, Probability Mass Function, Probability Density Function.. |
| Unit IV | **Expectation:** **D**efinition and types of Mathematical Expectation, Moments in terms of expectation, Mathematical and Multiplication theorems of Expectation, other theorems on expectation |
| Unit V | **Inequalities for Moments:** Cauchy-Schwartz Inequality, Markov's inequality, Chebyshev's inequality. |
| **Block 3** | **Concept of Probability Distributions** |
| Unit VI | **Univariate Distributions:** Bernoulli Distribution, Binomial Distribution, mean and variance of binomial distribution, Moments, Moments Generating Function, Additive and Multiplicative property, Recurrence relation for moments, Fitting of Binomial Distribution, Poisson Distribution, Poisson Distribution as a limiting case of Binomial Distribution, mean |

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| | and variance of Poisson distribution, Moments, Moment Generating Function, Additive and Reproductive property, Recurrence relation for moments, fitting of Poisson Distribution. |
| Unit VII | **Discreet Distribution:** Geometric Distribution, mean and variance, moment generating function of geometric distribution, Negative Binomial Distribution, Moment Generating Function, Mean and Variance, Recurrence formulae for negative Binomial Distribution, Poisson Distribution as a limiting case of Negative Binomial Distribution, Hyper Geometric Distribution, Mean and Variance, Recurrence relation for Hyper Geometric distribution.. |
| Unit VIII | **Normal Distribution:** Normal Distribution and its parameters, Standard Normal Distribution, Moments, Moments Generating Function, Area Property, properties of normal curve, Standard Scores, Advantages and Characteristics of Z Scores |
| Unit IX | **Continuous Distribution:** Uniform Distribution, Moment Generating Function, Distribution Function, Moments of Uniform Distribution, Exponential Distribution, Moments, Moment Generating Function, Lack of Memory Property |
| Unit X | **Sampling Distribution:** Sampling distribution of a statistic, Parameter, Derivation of $\chi^2$, t, F, z distributions, Beta, Gamma, Chauchy densities. |
| **Block 4** | **Basic Principles of Statistical Inference** |
| Unit XI | **Estimation:** Point Estimation, properties of a good estimator, Consistency, Unbiasedness, Efficiency, Sufficiency, Confidence Interval Estimation. |
| Unit XII | **Method of Estimation:** Procedures of Estimation, Method of Moments, method of Maximum Likelihood, Method of Scoring, Properties of Estimators. |
| Unit XIII | **Testing of Hypothesis:** Statistical Hypothesis, Simple and Composite Hypothesis, Critical Region, Two kinds of Error, One-tailed and Two-tailed tests, Test of Significance, Most Powerful Test, Uniformly Most Powerful Test . |
| **Block 5** | **Test of Significance** |
| Unit XIV | **Exact Tests and Fisher's transformations:** Tests of Significance based on Chi-Square Distribution, Tests of Significance based on t – Distribution, Tests of Significance based on F – Distribution, Tests of Significance based on Fisher's Z - Distribution. |
| Unit XV | **Large Sample Tests:** Testing Significance of Mean, Testing Equality of Means, Testing Significance of Proportion, Testing Equality of Proportions, Testing Significance of Standard Deviation, Testing Equality of Standard Deviation |
| Unit XVI | **Non-Parametric Tests:** Non Parametric Tests, Sign Test, Wilcoxon Signed- Rank Test, Mann- Whitney U-Test, Run Test. |

## Suggested Text Book Readings:

- Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997):Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.
- Edward P.J., Ford J.S.and Lin (1974): Probability for Statistical Decision-Making, Prentice Hall.
- Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
- David S (1996): Elementary Probability, Oxford Press.
- Hoel P.G (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer P.L (1970): Introductory Probability and Statistical applications. Addision Wesley.
- Freund J.E (2001): Mathematical Statistics, Prentice Hall of India.
- Hodges J.L and Lehman E.L (1964): Basic Concepts of Probability and Statistics, Holden Day.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Rohatgi V.K (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons.
- Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University Press.

| This course can be opted as an elective by the students of following subjects: |
|---|
| U.G/P.G. in Mathematics, Data Science, Computer Science, Agricultural Sciences, all Life Sciences and Social Sciences subjects students etc |
| Suggested equivalent online courses (MOOCs) for credit transfer: NA |

**Learner can join this for their own knowledge:**
1. https://*onlinecourses*.nptel.ac.in/noc, Probability and RandomProcesses, Prof Rohit Sinha and Prof. Ribhu
2. https://onlinecourses.nptel.ac.in/noc, Non-parametric Statistical Inference, Prof. Niladri  Chatterjee

**Electronic media and other digital components in the curriculum:**
**Choose any one or more than one:**(Electronic Media: Audio/Video Lectures, Online Counselling/Virtual Classes/E-Contents/e-SLM/OER/supplementary links for reference/Video Conferencing/Radio broadcast/Web Conferencing/ Other electronic and digital contents)

| S. No. | Course Code | Title | Uploaded Date & link |
|---|---|---|---|
| 1. | UGSTAT – 102 Block – I, Unit – II | Probability Distribution and Statistical Inference, Probability Theory,Conditional Probability | uploaded on *20.09.2021*, *https://youtu.be/7P-dvJIEs1g* |
| 2. | UGSTAT – 102 Block – I, Unit – I | Probability Distribution and Statistical Inference, Probability Theory,Random Experiments and Probability | uploaded on *23.09.2021*, *https://youtu.be/hr0frb7K-9c* |

| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** I | **Semester:** II |
| **Subject:** Statistics | | |
| **Course Code:** *UGSTAT-102NP* | **Course Title:** *Practical and Viva voce* | |

**Course Objectives:** The main objective of this course is to develop a skill to: understand the practical methods and tests related to estimation of real-life data.

**Course Outcomes:**
**CO1:** Learner should able to solve the numerical problems related with Probability theory.
**CO2:** Learner should able to solve the numerical problems related with distributions.
**CO3:** Learner should able to solve the numerical problems related with sampling distributions.
**CO4:** Learner should able to solve the numerical problems related with Non parametric tests.

| **Credits:** 2 | **Type of Course:** Core |
|---|---|
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |
| *Practical based on UGSTAT-102N* | |

| Course prerequisites: | For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|---|

| Programme: B.Sc./B.A. | Year: II | Semester: III |
|---|---|---|

**Subject:** Statistics

| Course Code:*UGSTAT -103 (N)* | Course Title:*Sampling Theory and Design of Experiments* |
|---|---|

**Course Objectives:** To understand the concept of sampling distributions and their applications in statistical inference. To understand the process of hypothesis testing. To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis. To learn how the mathematical ideas of Statistics carry over into the world of applications. Drawing inference about the unknown population parameters based on random samples. Validating our estimation/ inference about the population using hypothesis testing. To provide tools and techniques for selecting a sample of elements from a target population keeping in mined the objectives to be fulfilled and nature of population. To obtain estimator of the population parameter on the basis of selected sample and study its properties. To understand the knowledge about the principles of design of experiments, linear models and also CRD, RBD and LSD.

**Course Outcomes:**

**CO1:** This course gives the concept of population, census and statistic, types of survey, sampling and Sampling over complete enumeration .Simple Random Sampling with and without replacement, Stratified sampling, Systematic Sampling.

**CO2:** Under this course learner will able to understand the knowledge of auxiliary variable, Ratio and Regression Method of estimation, Cluster sampling, Two Stage Sampling, Two Phase Sampling and also Multi Stage Sampling, Non Sampling errors: Response Errors and Non Response Errors.

**CO3:** Learner will able to understand the Analysis of Variance (ANOVA), and linear model.

**CO4:** Learner will able to understand concept about the Design of Experiments, CRD, RBD and LSD.

| Credits: 2 | Type of Course: Core |
|---|---|

| Max. Marks:100 | Min. Passing Marks:36 |
|---|---|

| Block 1 | **Samplings Theory - I** |
|---|---|
| Unit I | **Simple Random Sampling:** Advantages of Sampling over Complete Enumeration, Sampling and Non Sampling Errors, Probability or Random Sampling, Bias of an Estimator, Measures of Sampling Error, Simple Random Sampling Without Replacement (SRSWOR) . |
| Unit II | **Stratified Random Sampling:** Introduction, Reasons & Advantages of Stratification, Some theorems**.** |
| Unit III | **Allocation of Sample Size and Systematic Sampling:** Introduction, Equal Allocation, Proportional Allocation, Variance of Stratified Mean under Proportional Allocation, Optimum Allocation, Variance of Stratified Mean under Neyman Allocation, Relationship Among Three Variances, Impact of Arbitrary Allocation, Practical difficulties in Implementing NeymanAlloation, Systematic Random Sampling. |
| Block 2 | **Sampling Theory - II** |
| Unit IV | **Ratio and Regression Methods of Estimation:** Introduction, Ratio and Regression Estimators, Approximate Variances of the Ratio Estimators |
| Unit V | **Cluster and Two Stage Sampling:** Cluster Sampling (Equal Cluster- Size), Estimation of Mean with SRS at both Stages, Relative Efficiency of Cluster Sampling, Two Stage Sampling, Estimation of Mean, Optimum Allocation when Cost Fixed and when Variance Fixed, Two-Phase (Double) Sampling for Stratification, Estimation of Mean, Difference between Multistage Sampling and Two Phase Sampling. |
| Unit VI | **Non- Sampling Errors: Response Error and Non Response Errors:** Introduction, Errors in Sampling, Sampling Errors, Non Sampling Errors, Response Errors, Sources of Non Sampling Errors, Method of Minimizing Non- Response Errors. |
| Block 3 | **Design and Analysis of Experiments** |
| Unit VII | **Analysis of Variance, Design of Experiment and Completely Block Design:** Analysis of Variance, Linear Models and Analysis of Variance, Design of Experiment, Basic Principles of |

| | |
|---|---|
| | Design of Experiments, Completely Randomized Design. |
| Unit VIII | **Randomized Block Design and Latin square Design:** Randomized Block Design, Efficiency of RBD, Missing Plot Technique, Latin Square Design, and Efficiency of LSD |
| Unit IX | **Factorial Experiment:**<br>Definition, $2^2$ and $2^3$ factorial experiments with its ANOVA table |

# Suggested Text Book Readings:

- Cochran W.G and Cox G.M (1957): Experimental Designs, John Wiley and Sons.
- Das M.N and Giri (1986): Design and Analysis of Experiments, Springer Verlag
- Murthy M. N (1967): Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
- Sampath S. (2000): Sampling Theory and Methods, Narosa Publishing House.
- Sukhatme B. V (1984): Sample Survey methods and Its Applications, Indian Society of Agricultural Statistics.
- Des Raj (2000): Sample Survey Theory, Narosa Publishing House.
- Goon A. M., Gupta M. K., Das Gupta. B. (1986): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
- Kempthorne O. (1965): The Design and Analysis of Experiments, Wiley Eastern.

**This course can be opted as an elective by the students of following subjects:**
U.G/P.G. in Agricultural Sciences, all Life Sciences and Social Sciences subjects students etc

**Suggested equivalent online courses (MOOCs) for credit transfer:** NA

| Course prerequisites: For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** II | **Semester:** III |
| **Subject:** Statistics | | |
| **Course Code:** *UGSTAT-103 (N)(P)* | **Course Title:** *Practical and Viva voce* | |

**Course Objectives:** The main objective of this course is to develop a skill to: understand the practical methods and tests related to estimation of real-life data.

**Course Outcomes:**

**CO1:** Learner should able to solve the numerical problems related with Simple random sampling theory.

**CO2:** Learner should able to solve the numerical problems related with stratified sampling.

**CO3:** Learner should able to solve the numerical problems related with systematic sampling.

**CO4:** Learner should able to solve the numerical problems related with cluster sampling.etc

**CO5:** Learner should able to solve the numerical problems related with CRD, RBD and LSD.

**CO6:** Learner should able to solve the numerical problems related with one way and two way analysis etc

| **Credits:** 2 | **Type of Course:** Core |
|---|---|
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |
| *Practical based on UGSTAT-103(N)* | |

| | |
|---|---|
| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

| | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** II | **Semester:** IV |

**Subject:** Statistics

| | |
|---|---|
| **Course Code:** *UGSTAT -104(N)* | **Course Title:** *Applied Statistics* |

**Course Objectives:**

**Course Outcomes:**

**CO1:** This course gives the complete knowledge about the Index number, Price Index number, Cost Index number, criterion of a good index number.

**CO2:** Under this course, learner will able to understand the knowledge about the Time Series Analysis, its utility, component, mathematical models, determination of trends and seasonal indices.

**CO3:** Learner will able to understand about the concept of Demography, vital statistics, concept of fertility, mortality with their measurements and also knowledge of life table and measures of reproductively.

**CO4:** Learner will also persist the knowledge about Statistical Quality Control, control charts for variables, control charts for attributes and also gain the knowledge of principles of acceptance sampling.etc

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|---|---|
| **Credits:** 2 | **Type of Course:** Core |

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|---|---|
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |

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|---|---|
| **Block 1** | **Index Numbers** |
| Unit I | **Index Number: General Theory:** Definition & Construction of an Index number, Price Relatives, Quantity or Volume Relatives, Value Relatives, Link & Chain Relatives, Problem involved in computation of an Index Number . |
| Unit II | **Index Numbers: Important Formulae:** Introduction, Calculation of Index Number, Laspeyre's, Paasche's, Marshall- Edgeworth's, fisher's formulae, other indices, Quantity Index, Criteria of good Index Number |
| Unit III | **Consumer Price Index Number:** Introduction, Construction & Computation of Consumer Price Index Number (CPI), Steps in construction of CPI, Use & Limitations of CPI, Base Shifting of Index Numbers, Splicing of Index Number Series, Deflating the Index Number, Index of Industrial Production |
| **Block 2** | **Time Series Analysis** |
| Unit IV | **Time Series:** Introduction, Utility of Time Series Analysis, Component of Time Series, Mathematical Models for Time Series Analysis. |
| Unit V | **Determination of Trends:** Introduction, Graphic Method, Method of Semi Averages, Method of Curve Fitting by the Principle of Least Squares, Method of Moving Averages (when Period is Even & Odd) |
| Unit VI | **Determination of Seasonal Indices:** Introduction, Measurement of Seasonal Indices, Method of Simple Averages, Ratio to Trend Method, Ratio to Moving Average Method, Method of Link Relatives |
| **Block 3** | **Demography** |
| Unit VII | **Sources of Demographic Data :** Introduction, Demography & Vital Statistics, Sources of Demographic Data, Errors in Data Collection, Evaluation & its Adjustments, Rates & Ratios |
| Unit VIII | **Measures of Mortality:** Introduction, Measures of Mortality, CDR, SDR, StDR, MMR, IMR. |
| Unit IX | **Measures of Fertility :** Introduction, Measures of Fertility, CBR, GFR, ASFR, TFR. |
| Unit X | **Life Tables:** Introduction, Description & Construction of Complete Life Table, Uses of a Life Table. |
| Unit XI | **Measures of Reproductively:** Introduction, GRR, NRR. |
| **Block 3** | **Statistical Quality Control** |

| Unit XII | **Introduction of Statistical Quality Control :** Introduction, Advantages of Quality Control, Quality Characteristics, Basic Principles & Operating Characteristics of Control Charts, Choice of Control Limits, Sample Size & Sample Frequency, Rational Subgroups, Analysis of Pattern on Control Charts, Rate of Detection of Change in Average Level |
|---|---|
| Unit XIII | **Control Charts for Variables:** Introduction, Control Charts for Mean, Control Charts FDor Range, Control Charts for Standard Deviation |
| Unit XIV | **Control Charts for Attributes:** Introduction, Control Charts for Fraction Defectives, Control Charts for Number of Defectives, Control Charts for Number of Defects |
| Unit XV | **Principles of Acceptance Sampling:** Introduction, AQL, LTPD, Producer's Risk, Consumer's Risk, OC Function, AOQ, Average Total Inspection, Average Sample Number, Single Sampling Plan, Double Sampling Plan, Sampling Inspection by Variables |

**Suggested Text Book Readings:**
- Croxton F.E and Cowden D.J. (1969) : Applied General Statistics, Prentice Hall of India.
- Goon A.M., Gupta M. K., Das Gupta. B. (1986): Fundamentals of Statistics, Vol. II, World Press, Calcutta.
- Guide to Current Indian Official Statistics: Central Statistical Organization, Govt. ofIndia, New Delhi.
- Saluja M. P ( ) Indian Official statistical Systems, Statistical Publishing Society,Calcutta.
- Srivatava O.S (1983): A Textbook of Demography, Vikas Publishing.
- Gupta and Mukhopadhyay P.P ( ) Applied Statistics, Central Book Agency.
- Pressat R (1978) : STATISTICAL Demography, Methuen and Co. Ltd.

**This course can be opted as an elective by the students of following subjects:**
U.G/P.G. inCommerce, Business studies, population studies, economics, all Life Sciences and Social Sciences subjects students etc

**Suggested equivalent online courses (MOOCs) for credit transfer:**NA

| Course prerequisites: For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the Concerned Course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** II | **Semester:** IV |
| **Subject:** Statistics | | |
| **Course Code:** *UGSTAT-104NP* | **Course Title:** *Practical and Viva voce* | |
| **Course Objectives:** The main objective of this course is to develop a skill to: understand the practical methods and tests related to estimation of real-life data. | | |
| **Course Outcomes:**<br>**CO1:** Learner should able to solve the numerical problems related with Index number.<br>**CO2:** Learner should able to solve the numerical problems related with Time series analysis.<br>**CO3:** Learner should able to solve the numerical problems related with Demography.<br>**CO4:** Learner should able to solve the numerical problems related with Statistical Quality Control. | | |
| **Credits:** 2 | **Type of Course:** Core | |
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 | |
| *Practical based on UGSTAT-104N* | | |

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| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

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|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** V |

**Subject:** Statistics

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|---|---|
| **Course Code:** *UGSTAT -105 (N)* | **Course Title:** *Advance Statistical Inference* |

**Course Objectives:** Study of theoretical concepts of Point Estimation & Cramer Rao Inequality, Sufficiency & Factorization Theorem, Complete Sufficient Statistics & Rao Blackwell Theorem, Complete Sufficient Statistics, MP & UMP Tests, Neyman- Pearson Lemma, Likelihood Ratio Test & Their Uses, Shortest Unbiased Confidence Intervals.

**Course Outcomes:**

**CO1:** Under this course learner will able to understand about the concept of statistical inference, point estimation, cramer rao inequality and MVUE.

**CO2:** Learner will able to understand about the Sufficiency and factorization theorem, rao Blackwell theorem and invariance property.

**CO3:** This course also discuss about the minimum variance unbiased estimation, completeness, lehmann Scheffe theorem and Neyman Pearson Lemma.

**CO4:** Learner should also able to understand about the Neyman- Pearson Lemma, Likelihood Ratio Test & Their Uses, Testing of Means of Normal Population, Confidence Interval & Confidence Coefficient, Neyman's Principle of Shortest Confidence Interval, Unbiased Confidence Interval and Shortest Unbiased Confidence Interval.

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|---|---|
| **Credits:** 2 | **Type of Course:** Discipline Centric Elective |

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|---|---|
| **Max. Marks:**100 | **Min. Passing Marks:**36 |

| **(Syllabi should be framed block wise/unit wise; No of blocks and units may change)** | |
|---|---|
| **Block 1** | **Point Estimation** |
| Unit I | **Introduction to Statistical Inference:** Introduction, Parameter & Statistic, Parametric & Non-Parametric Methods, Likelihood Function of Sample Values, Sampling Distribution, Standard Error of the Statistic |
| Unit II | **Point Estimation & Cramer Rao Inequality:** Introduction, Point Estimation, Properties of Estimators, Unbiasedness, Consistency, Efficiency, MVUE, C-R Inequality |
| Unit III | **Sufficiency & Factorization Theorem:** Introduction, Sufficiency, Neymam- Fisher Factorization Theorem, Koopmam's form of the Distribution, Invariance Property of Sufficient Statistics. |
| Unit IV | **Complete Sufficient Statistics & Rao Blackwell Theorem:** Introduction, Complete Family of Distributions, Rao-Blackwell Theorem |
| **Block 2** | **MVU Estimation** |
| Unit V | **MUV Estimators :** Introduction, Minimum Variance Unbiased Estimation, Some Theorems on MVUE |
| Unit VI | **Complete Sufficient Statistics:** Introduction, Sufficient Statistic & Completeness, Lehmann- Scheffe Theorem, Construction of UMVUE |
| **Block 3** | **Testing of Hypothesis - I** |
| Unit VII | **Preliminary Concepts in Testing:** Introduction, Types of Hypothesis, Types of Error, Critical Region, Power Function. |
| Unit VIII | **MP & UMP Tests :** Introduction, Most Powerful Test, Uniformly Most Powerful Test |
| **Block 4** | **Testing of Hypothesis -II** |
| Unit IX | **Neyman- Pearson Lemma, Likelihood Ratio Test & Their Uses :** |

| | | |
|---|---|---|
| | Introduction, Neyman-Pearson Lemma, Likelihood Ratio Test. | |
| Unit X | **Testing of Means of Normal Population :** | |
| | Introduction, One Sample Problem, Two Sample Problem | |
| Unit XI | **Interval Estimation :** | |
| | Introduction, Confidence Interval & Confidence Coefficient, C.I. For Sample Mean from a Normal Population, C.I. for differences of Means From Two Normal Population. | |
| Unit XII | **Shortest & Shortest Unbiased Confidence Intervals :** | |
| | Introduction, Intervals of Shortest Length, Neyman's Principle of Shortest Confidence Interval, Unbiased Confidence Interval, Shortest Unbiased Confidence Interval, Case of Discreet Random Variables. | |

**Suggested Text Book Readings:**
- Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997):Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.
- Edward P.J., Ford J.S.and Lin (1974): Probability for Statistical Decision-Making, Prentice Hall.
- Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
- David S (1996): Elementary Probability, Oxford Press.
- Hoel P.G (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer P.L (1970): Introductory Probability and Statistical applications. Addision Wesley.
- Freund J.E (2001): Mathematical Statistics, Prentice Hall of India.
- Hodges J.L and Lehman E.L (1964): Basic Concepts of Probability and Statistics, Holden Day.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Rohatgi V.K (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons.
- Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University Press.

**This course can be opted as an elective by the students of following subjects:**
U.G/P.G. in Mathematics, Data Science, Computer Science subjects students etc

Suggested equivalent online courses (MOOCs) for credit transfer: NA

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|---|---|
| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

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|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** V |

**Subject:** Statistics

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|---|---|
| **Course Code:** *DECSTAT -106 (N)* | **Course Title:** *Basic Knowledge of Statistical Software* |

**Course Objectives:** To introduce some advanced statistical computing techniques to extract information, visualization and knowledge about various industries. To learn the principles and methods of data analysis. To provide a basic understanding of methods of analyzing data from different fields. To learn R software. The main objective of this course is to allow the learners to learn the advanced techniques of modeling real data from diverse discipline

**Course Outcomes:**

**CO1:** Learner should able to understand about the concept and practical hands on about statistical software.
**CO2:** Understand about SPSS, Stata with statistical applications.
**CO3:** Understand about R and R commander with statistical applications..
**CO4:** Understand about Matlab and Latex etc..

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| **Credits:** 2 | **Type of Course:** Discipline Centric Elective |

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|---|---|
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |

| Block 1 | Statistics with MS Office |
|---|---|
| Unit I | **MS Office and its components:** About Statistical Softwares, its features and the steps for data analysis with related softwares Introduction to system software and application software, word processing software – Microsoft office Word, spread sheet software – Microsoft office excel, presentation software – Microsoft office Power Point (Interface of all the three application software, file handling, editing, formatting and final output). Excel as data base software: cell referencing, concept of list, data sorting and filtering, manipulation of data, naming of cells |
| Unit II | **Computation with MS Excel:** Functions specifically Numeric/Mathematical functions, Statistical Functions, Logical Functions, lookup functions, Statistical Analysis using Excel – Descriptive Statistics, Curve fitting, correlation and regression analysis, graphs |
| Block 2 | Statistical Computation with R |
| Unit III | **Basics of R:** Basics of R, R Studio and R-Commander, creation of data files. Import Export of Data files, Transformation of Data. |
| Unit IV | **Statistical Analysis with R:** Statistical Analysis using R – Descriptive Statistics, Curve fitting, correlation and regression analysis, graphs. |
| Unit V | **Testing of Hypothesis with R:** Testing of hypothesis using R. |

**Suggested Text Book Readings:**

- Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997): Statistics: A Beginner's Text, Vol. II, New Age International (P) Ltd.
- Edward P.J., Ford J.S.and Lin (1974): Probability for Statistical Decision-Making, Prentice Hall.
- Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Cooke, Cramer and Clarke (): Basic Statistical Computing, Chapman and Hall.
- David S (1996): Elementary Probability, Oxford Press.
- Hoel P.G (1971): Introduction to Mathematical Statistics, Asia Publishing House.
- Meyer P.L (1970): Introductory Probability and Statistical applications. Addision Wesley.
- Freund J.E (2001): Mathematical Statistics, Prentice Hall of India.
- Hodges J.L and Lehman E.L (1964): Basic Concepts of Probability and Statistics, Holden Day.
- Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Rohatgi V.K (1967): An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons.

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| • Snedecor G.W and Cochran W. G. (1967): Statistical Methods. Iowa State University Press. |
| **This course can be opted as an elective by the students of following subjects:**<br>U.G/P.G. in Mathematics, Data Science, Computer Science, Agricultural Sciences, all Life Sciences and Social Sciences subjects students etc |
| Suggested equivalent online courses (MOOCs) for credit transfer: NA |
| **Learner can join this for their own knowledge:**<br>1. https://*onlinecourses*.nptel.ac.in/noc, Descriptive Statistics With R Software, Prof. Prashant Jha<br>2. https://onlinecourses.nptel.ac.in/noc, Foundations of R Software, Prof. Shalabh<br>3. https://onlinecourses.nptel.ac.in/noc, Probability –Ii with Examples Using R, Prof Siva Athreya. |

| Course prerequisites: For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** V |
| **Subject:** Statistics | | |
| **Course Code:** *DECSTAT-107(N)(P)* | **Course Title:** *Practical and Viva voce* | |
| **Course Objectives:** The main objective of this course is to develop a skill to: understand the practical methods and tests related to estimation of real-life data. | | |
| **Course Outcomes:**<br> **CO1:** Learner should able to solve the numerical problems related with Statistical Inference.<br> **CO2:** Learner should able to solve the numerical problems related based on descriptive statistics with R.<br> **CO3:** Learner should able to solve the numerical problems related with Applied Statistics with R.<br> **CO4:** Learner should able to solve the numerical problems related with official statistics with R. | | |
| **Credits:** 2 | **Type of Course:** Discipline Centric Elective | |
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 | |
| Practical work based on DCESTAT-105 (N) and DCESTAT-106 (N) | | |

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| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

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|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** VI |

**Subject:** Statistics

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|---|---|
| **Course Code:** *DECSTAT -108 (N)* | **Course Title:** *Official Statistics* |

**Course Objectives:** To understand the concept of all theories and their practical knowledge. This program will gives a complete knowledge about the official statistics. To understand the concept of all theories and their practical knowledge. This program will give a complete knowledge about the audit sampling, audit risk, official and Bio statistics.

**Course Outcomes:**

**CO1:** Learner will able to understand the knowledge about official statistics, Statistical Methods for Total Quality Management, Quality Systems, ISO 9000 standards, QS 9000 standards. Concept of six-sigma.

**CO2:** Learner will understand concepts of population and sample need for sampling, census and sample surveys, basic concepts in sampling and designing of large scale surveys, non-sampling errors, randomized response technique (Warner's model only).

**CO3:** Learner have a concept of need for design of experiments, fundamental principles of design of experiments., Factorial Experiments, 2n, 32 factorial experiments, illustrations, main effects and interactions, confounding and illustrations.

**CO4:** This course persist the knowledge about statistical audit sampling, its advantage in audit, risk of statistical sampling, attributes vs variable sampling, audit hypothesis, testing of hypothesis, monetary unit sampling, risk based analysis, concept of alpha and beta risk, concept of tolerable misstatement.

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| **Credits:** 2 | **Type of Course:** Discipline Centric Elective |

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|---|---|
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |

| Block 1 | Official Statistics |
|---|---|
| Unit I | **Basics of Official Statistics:** About the official Statistics, Use of Statistics in different offices, Census, National Sample Survey Office, Sample Survey Organization, Birth and Death Registration. etc Introduction to Indian and International statistical systems. Role, function and activities of Central and State statistical organizations. Organization of large scale sample surveys. Role of National Sample Survey Organization. General and special data dissemination systems. |
| Unit II | **Application of Areas and Tools:** Population growth in developed and developing countries, evaluation of performance of family welfare programmes, projections of labour force and manpower. Scope and content of population census of India. System of collection of Agricultural Statistics. Crop forecasting and estimation, productivity, fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects. Statistics related to industries, foreign trade and balance of payment, cost of living, inflation, educational and other social statistics. |
| Unit III | **Statistical System and Functions of Various Agencies:** Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Principal publications containing data on the topics such as population, agriculture, industry, trade, prices, labour and employment, transport and communications, banking and finance. Various official agencies responsible for data collection and their main functions. |
| Block 2 | Statistical Methods for Total Quality Management |
| Unit IV | **Objectives and Basics of TQM:** Quality Systems, ISO 9000 standards, QS 9000 standards. Concept of six-sigma and the Define-Measure-Analyse-Improve-Control Approach. Precision and accuracy in measurement systems. Estimation of Measurement Uncertainty. Total Quality Management |
| Unit V | **Methodologies of TQM:** Process Analysis and Optimization. Quality at Design stage, |

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|---|---|
| | Quality Function Deployment, Failure Mode and Effect Analysis, Conjoint Analysis. System, parameter and tolerance designs. Planning and analysis of fractional factorial experiments. Basic ideas of response surface methodology and contour plots |
| Unit VI | **Process Quality and Capability Analysis:** Quality in manufacturing, control charts for attribute and variable characteristics, process adjustments based on control chart evidences. Process capability and performance indices. Evolutionary operations. Measuring customer satisfaction, American Customer Satisfaction Index Model. |

## Suggested Text Book Readings:
- Guide to current Indian Official Statistics. Central Statistical Organisation, Govt. of India, New Delhi.
- Saluja, M.P. ( ) : Indian official statistical systems. Statistical Publishing Society, Calcutta.

## This course can be opted as an elective by the students of following subjects:
U.G/P.G. in Business & Commerce, all Life Sciences and Social Sciences subjects students etc

Suggested equivalent online courses (MOOCs) for credit transfer: NA

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|---|---|
| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | |

| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** VI |
|---|---|---|

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|---|---|
| **Subject:** Statistics | |

| **Course Code:** *DECSTAT-109(N)* | **Course Title**: *Operation Research* |
|---|---|

**Course Objectives:** The main aim of this course is to develop the fundamental knowledge and understanding of theories and techniques of solving operations research problems in linear programming, inventory, simulation, queuing and reliability theory. To understand the knowledge about Operation Research, Graphical Method to Solve LPP, Simplex Method of Solving LPP, Duality Problem in LPP, Transportation Problem & Assignment Problem, Theory of Games, Dominance Rule, Equivalence of Rectangular Games with Linear Programming.

**Course Outcomes:**

**CO1:** Learner should able to under about the operation research, linear programming problem (LPP), graphical and simplex method for solving LPP.

**CO2:** Learner should able to know about duality problem, transportation problem and also assignment problem.

**CO3:** Under this course, learner should able to understand the concept about the game theory, dominance rule, linear programming

**CO4:** Understand discrete event simulation and decision analysis with inclusion of modeling based on random events involving uncertainties and Able to know the inventory, queuing and replacement models with their real life applications.

| **Credits:** 2 | **Type of Course:** Discipline Centric Elective |
|---|---|

| **Max. Marks:** 100 | **Min. Passing Marks:** 36 |
|---|---|

| **Block 1** | **Formulation of Linear Programming Problems** |
|---|---|
| Unit I | **Introduction to Operation Research:** Introduction, Phases of OR Problem, Operation Research Modeling Approach, Defining the Problem & Gathering Data, Formulating a Mathematical Models, Deriving Solution from the Model Introduction to Linear Programming, Formulation of a Linear Programming Problem with examples. |
| Unit II | **Graphical Method top Solve LPP:** Introduction, Graphical Solution to Linear Programming Problem. |
| **Block 2** | **Simplex Method of Solving LPP** |
| Unit III | **Simplex Method:** Introduction, Principle of Simplex Method, Simplex Method with Several Decision Variables, Two Phase & M-Method, Multiple, Unbounded Solution & Infeasible Problems, Sensitivity Analysis. |
| Unit IV | **Duality Problem in LPP:** Introduction, Dual Linear Programming Problem, Formulation of a Dual Problem with example. |
| **Block 3** | **Transportation Problem & Assignment Problem** |
| Unit V | **Representation of Transportation Problem (Non-Generated & Balanced Cases only) & Assignment Problem as Linear Programming Problem:** Introduction of T.P. & A.P., Transportation Problem as LPP, Non-Degenerate Transportation Problem, Balanced Transportation Problem, Assignment Problem &LPP, Balanced Assignment Problem. |

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| Unit VI | **Different Methods of Finding Initial Feasible Solution of a Transportation Problem (T.P., MODI Method of Finding Optimal Solution of a T.P.) :** Introduction, Basic Feasible Solution of a Transportation Problem, Modified Distribution Method (MODI), Vogel's Approximation Method (VAM), Maximization in a Transportation Problem |
| Unit VII | **Solution of Assignment Problem With using Hungarian Method :** Introduction, Solution of an Assignment Problem, Hungarian Method, Maximization in an Assignment Problem. |
| Block 4 | **Theory of Games** |
| Unit VIII | **Basic Concepts of Game Theory :** Introduction, A Game, Pure & Mixed Strategies, Two- Person Zero- Sum Game, Pay-Off Matrix, Games without Saddle Point and Mixed Strategies, Methods of Solving Game Problems. |
| Unit IX | **Dominance Rule, Equivalence of Rectangular Games with Linear Programming:** Introduction, Rectangular Games without Saddle Point, Dominance Property of reducing the Size of the Game, Solution Methods of Games without Saddle Point, Equivalence of Rectangular Games with Linear Programming |

**Suggested Text Book Readings:**

- Taha H.A. (1982) Operational Research: An Introduction; Macmillan.
- Hillier F.S. and Leiberman G.J. (1962) Introduction to Operations Research; Holden Day.
- Kanti Swarup, Gupta,P.K. and Singh,M.M.. (1985) Operations Research; Sultan Chand & Sons.
- Philips D.T.,Ravindran A. and Solberg J.( ) Operations Research, Principles and Practice.
- Churchman C.W., Ackoff R.L. and Arnoff E.L. (1957) Introduction to Operations Research; John Wiley.
- Hadley G. (1964) Non-linear and Dynamic programming;
- Addison Wesley Murthy K.G. (1976) Linear and Combinatorial Programming;
- John Wiley Kleinrock L. (1975) Queueing Systems, vol. 1, Theory;
- John Wiley Saaty T.L. (1961) Elements of Queueing Theory with Applications; McGraw Hill
- Hadley G. and Whitin T.M. (1963) Analysis of Inventory Systems; Prentice Hall
- Starr M.K. and Miller D.W. (1962) Inventory Control-Theory and Practice; Prentice Hall
- Mckinsey J.C.C. (1952) Introduction to the Theory of Games; McGraw Hill
- Wagner H.M. (1973) Principles of O.R. with Applications to Managerial Decisions; Prentice Hall
- Gross, D. Harris,C.M. (1974) Fundamentals of Queueing Theory; John Wiley

**This course can be opted as an elective by the students of following subjects:**
P.G. in computer science, Data science, Mathematics, MBA  and engineering students etc.

**Suggested equivalent online courses (MOOCs) for credit transfer:** NA

**Learner can join this for their own knowledge:** *https://onlinecourses.nptel.ac.in/noc,*
Operations Research, Prof. Kusumdeep

| | | | |
|---|---|---|---|
| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | | |
| **Programme:** B.Sc./B.A. | | **Year:** III | **Semester:** VI |
| **Subject:** Statistics | | | |
| **Course Code:** *DECSTAT-110(N)(P)* | | **Course Title:** *Practical and Viva voce* | |
| **Course Objectives:** The main objective of this course is to develop a skill to: understand the practical methods and tests related to estimation of real-life data. | | | |
| **Course Outcomes:**<br> **CO1:** Learner should able to solve the numerical problems related with Operation research.<br> **CO2:** Learner should able to solve the numerical problems related based on descriptive statistics.<br> **CO3:** Learner should able to solve the numerical problems related with Applied Statistics.<br> **CO4:** Learner should able to solve the numerical problems related with official statistics. | | | |
| **Credits:** 2 | | **Type of Course:** Discipline Centric Elective | |
| **Max. Marks:** 100 | | **Min. Passing Marks:** 36 | |
| Practical work based on DCESTAT-108 (N) and DCESTAT-109 (N) | | | |

| **Course prerequisites:** For the study of the said course, the learner must fulfill all the eligibility criteria prescribed by the university for the concerned course. | | |
|---|---|---|
| **Programme:** B.Sc./B.A. | **Year:** III | **Semester:** VI |
| **Subject:** Statistics | | |
| **Course Code:** *SBSSTAT -04 (N)* | **Course Title:** *Numerical Methods & Basic Computer Knowledge* | |
| **Course Objectives:** To study the Numerical Analysis, this is the study of algorithms that use numerical approximation for the problems of mathematical analysis and also the basic knowledge of the computers. To define, design and model; To analyze; To identify the real life applications of stochastic processes. To study various Operational Research Techniques and Models. | | |
| **Course Outcomes:** <br> **CO1:** This course provides the knowledge of finite differences, interpolation with equal and unequal intervals, Lagrange's Interpolation. <br> **CO2:** Under this course learner will able to understand about the Central Differences, Inverse Interpolation, Numerical Differentiation and also Numerical Integration. <br> **CO3:** Learners also learn about the introduction and history of computers, generations of computers. It gives the knowledge about the hardware and system software.. <br> **CO4:** This course also provides the knowledge about the basic computer programming, concept of algorithm, flow charts and also programming languages.. | | |
| **Credits:** 4 | **Type of Course:** Skill Development | |
| **Max. Marks:** 100 | **Min. Passing Marks:** 36 | |
| **Block 1** | **Solutions of Non-Linear Equations in one Variable** | |
| Unit I | **Basic Properties of Equations:** Review of Calculus, Round off Error, Truncation Error, Some properties of equations, Iteration Methods for finding the roots (zero's) of an equation. Convergence Criterion, Initial Approximation to a Root, Bisection Method | |
| Unit II | **Solutions of Non-Linear Equations:** Fixed Point Iteration Method, Chord Methods for Finding Roots- Regula Falsi Method, Newton Raphson Method. Order of convergence | |
| **Block 2** | **Finite Differences** | |
| Unit III | **Finite Differences:** Forward Difference Operator, Difference Table, The Operator E, The Operator D, Backward Differences, Factorial Polynomial, Central Differences, Mean Operator. | |
| Unit IV | **Interpolation with Equal Intervals:** Introduction, Missing Values, Newton- Gregory Forward & Backward Interpolation Formula | |
| Unit V | **Interpolation with Un-Equal Intervals:** Introduction, Missing Values, Properties of Divided Differences, Newton's Divided Difference Interpolating Polynomial, Error of the interpolation Polynomial Divided Differences and Derivatives | |
| Unit VI | **Lagrange's Interpolation:** Introduction, Lagrange's Interpolating Polynomial, General Error term or Reminder Term, Linear Interpolation, error in Linear Interpolation | |
| **Block 3** | **Central Differences** | |
| Unit V | **Central Difference Interpolation Formulae:** Introduction, Gauss Forward & Backward Formulae, Stirling's Formula, Bessel's Formula, Bessel's Formula for halves | |
| Unit VI | **Inverse Interpolation:** Inverse Interpolation by Lagrange's method, method of Successive Approximation, Method of Reversion of Series | |
| Unit VII | **Numerical Differentiation:** Introduction, Numerical Differential for Equal Intervals, Numerical Differential for Un-Equal Intervals, Approximation Formulae for the Derivative of a Function. | |
| Unit VIII | **Numerical Integration:** Introduction, Trapezoidal Rule, Simpson's One-Third Rule, Simpson's Three-Eighth Rule, Waddle's Rule, Eular-Maculerian Formula. | |
| **Block 4** | **Solution of Differential Equations** | |

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| Unit IX | **Numerical Solution of Ordinary Differential Equations**-**I:**<br>(first order) by Picard's Iteration Method, Euler's Method, Runge- Kutta Methods- $4^{th}$ Order |
| Unit X | **Numerical Solution of Ordinary Differential Equations-II:**<br>(second order and simultaneous) by Picard's Iteration Method, Euler's Method, Runge- Kutta Methods- $4^{th}$ Order. |
| **Block 5** | **Computer** |
| Unit XI | **Introduction to Computer :** Introduction, Characteristics of computer, Historical Evaluation of Computer, Generation of Computers, Classification of computers. |
| Unit XII | **Hardware:** Introduction, CPU, Memory Organization, Input-Output Devices |
| Unit XIII | **System Software:** Introduction, System Software, File Commands, Editing, Commands, Disk Management Commands, Number System |
| **Block 3** | **Basics of Computer Programming** |
| Unit XIV | **Algorithm & Flow Charts :**<br>Introduction, Algorithm, Flow Charts |
| Unit XV | **Programming Language:**<br>Introduction, Machine Language, Assembly Language & Assembler, High Level Language, Object Oriented Programming, Programming Language Generation |

**Suggested Text Book Readings:**

- Guide to current Indian Official Statistics. Central Statistical Organisation, Govt. of India, New Delhi.
- Saluja, M.P. ( ) : Indian official statistical systems. Statistical Publishing Society, Calcutta.

**This course can be opted as an elective by the students of following subjects:**

U.G/P.G. in Business & Commerce,  all Life Sciences and Social Sciences subjects students etc

Suggested equivalent online courses (MOOCs) for credit transfer: NA