## Progressive Education Society's

# Modern College of Arts, Science and Commerce Pune 16

### (An Autonomous College Affiliated to Savitribai Phule Pune University)

**Three Year B.Sc. Degree Program in Statistics**

**(Faculty of Science & Technology)**

**F. Y. B. Sc. Statistics**

**Choice Based Credit System Syllabus**

**To be implemented from Academic Year 2022-2023**

Modern College, Ganeshkhind, Pune

**Title of the program:** F. Y. B. Sc. Statistics/ Statistical Techniques

**Preamble of the syllabus:**

Statistics is used even by common man in everyday life knowingly or unknowingly.
In these days the knowledge of Statistics is must because a large amount of data are created because of the use of computers, social media etc. For running any type of business efficiently converting the information in the knowledge is getting more and more important. Personnel at different level can use the data with different context. But condensed data or data converted into better form i.e. valuable information enhances the efficiency of such personnel.

Whenever the variation occurs, Statistical techniques help in drawing valuable conclusions from such information. Statistics consist of various methods of collection, organization and drawing inference of data.
Whenever the variability occurs Statistics becomes indispensable tool for converting such huge information into knowledge, and hence used in almost all fields.
There is a continuous demand for statisticians in every field – education, industry, software, insurance, clinical trials data and research. The syllabus of the three Year B. Sc. degree course in Statistics is framed in such a way that the students at the end of the course can apply judiciously the statistical tools to a variety of data sets to arrive at some conclusions.

Statistics can be divided into two broad categories, (1) exploratory statistics or descriptive statistics, which is concerned with summarizing data and describing these data, and (2) confirmatory statistics or inferential statistics, which is concerned with making decisions about the population based on the sample.

B. Sc. in Statistics program is of three years duration, with semester pattern for all the three years. A student of three-year B.Sc. degree program will not be allowed to offer Statistics and Statistical Techniques simultaneously in any of the three years of the course. Students offering

At **first year of under-graduation**, students will be given the basic information that includes different methods of data representation and summarization. Correlation and regression are the forecasting tools that are frequently used in statistical analysis. These topics are studied in one of the papers in each semester. Further they are introduced to probability and different discrete probability distributions along with applications in the other paper. Relevant experiments on these topics will be included in practical course. Further the students are expected start using some statistical software and verify the computations during practical. It is a skill oriented part of the course.

At **second year of under-graduation,** students are expected to study various probability distributions and its applications to real life situations. It is a foundation for further theory. An important branch of Statistics, viz. testing of hypotheses related to mean, variance, proportion, correlation etc. will be introduced. Some topics related to applications of Statistics will be also introduced. Further the students are expected start using some statistical software and verify the computations during practical. It is a skill oriented part of the course.

At **third year of under-graduation**, six theory papers deal with theoretical as well as applied aspect of statistics. Some papers such as distribution theory and parametric inference are core and mathematical in nature. Some papers such as sampling methods and Design of Experiments are core and applied but less mathematical. In Design of Experiments paper, various designs used in agriculture and industry are studied agriculture, clinical trials. Papers of applied nature, like medical statistics, actuarial statistics, time series, and optimization techniques (operations research), statistical quality control. There are some skill oriented courses C programming and R software. There are three practical courses based on core courses. In one of

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the practical courses, project component will be introduced to get hands on training or experiential learning.

## Evaluation Scheme:

**Theory paper:**    end semester examination (ESE):            35 marks
                     (At the end of each semester)
                     Continuous Internal Assessment (CIA):      15 marks

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                                                        Total    : 50 marks
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**Practical paper:**    end semester examination (ESE):         **35 marks**
                        (At the end of each semester)
                        **Continuous Internal Assessment (CIA)**

                        Journal day to day work      :         5 Marks
            Viva based on day to day experiments   :         5 Marks
                        Small project in a group   :          5 Marks

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            **Total of internal evaluation:**              **15 Marks**

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                                                        Total    : 50 marks
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## Structure of the Course

Structure of the course for three years and the pattern of examination and question papers are as specified below:

**Structure of F. Y. B. Sc. Statistics/ Statistical Techniques:**

| Semester | Paper Code | Paper | Paper title | No. of credits | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| 1 | 22-ST-111 | I | Descriptive Statistics I | 2 | 15 | 35 | 50 |
| | 22-ST-112 | II | Discrete Probability | 2 | 15 | 35 | 50 |
| | 22-ST-113 | III | Statistics Practical Paper I | 1.5 | 15 | 35 | 50 |
| 2 | 22-ST-121 | I | Descriptive Statistics II | 2 | 15 | 35 | 50 |
| | 22-ST-122 | II | Discrete Probability  Distributions | 2 | 15 | 35 | 50 |
| | 22-ST-123 | III | Statistics Practical Paper II | 1.5 | 15 | 35 | 50 |

**Structure of S. Y. B. Sc. Statistics:**

| Semester | Paper Code | Paper | Paper title | No. of credits | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| 3 | 23-ST-231 | I | Statistics theory paper  1 | 2 | 15 | 35 | 50 |
| | 23-ST-232 | II | Statistics theory paper  2 | 2 | 15 | 35 | 50 |
| | 23-ST-233 | III | Statistics Practical Paper I | 2 | 15 | 35 | 50 |
| 4 | 23-ST-241 | I | Statistics theory paper  1 | 2 | 15 | 35 | 50 |
| | 23-ST-242 | II | Statistics theory paper  2 | 2 | 15 | 35 | 50 |
| | 23-ST-243 | III | Statistics Practical Paper II | 2 | 15 | 35 | 50 |

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**Structure of T. Y. B. Sc. Statistics:**

| Semester | Paper Code | Paper | Paper title | No. of credits | CIA | ESE | Total |
|---|---|---|---|---|---|---|---|
| | 24-ST-351 | I | Statistics theory paper 1 | 2 | 15 | 35 | 50 |
| | 24-ST-352 | II | Statistics theory paper 2 | 2 | 15 | 35 | 50 |
| | 24-ST-353 | III | Statistics theory paper 3 | 2 | 15 | 35 | 50 |
| | 24-ST-354 | IV | Statistics theory paper 4 | 2 | 15 | 35 | 50 |
| | 24-ST-355 | V | Statistics theory paper 5 | 2 | 15 | 35 | 50 |
| 5 | 24-ST-356 | VI | Statistics theory paper 6 | 2 | 15 | 35 | 50 |
| | 24-ST 357 | VII | Statistics Practical Paper I | 2 | 15 | 35 | 50 |
| | 24-ST-358 | VIII | Statistics Practical Paper II | 2 | 15 | 35 | 50 |
| | 24-ST-359 | IX | Statistics Practical Paper III | 2 | 15 | 35 | 50 |
| | 24-ST-3510 | X | Skill enhancement course 1 | 2 | 15 | 35 | 50 |
| | 24-ST-3511 | XI | Skill enhancement course 2 | 2 | 15 | 35 | 50 |
| | 24-ST-361 | I | Statistics theory paper 1 | 2 | 15 | 35 | 50 |
| | 24-ST-362 | II | Statistics theory paper 2 | 2 | 15 | 35 | 50 |
| | 24-ST-363 | III | Statistics theory paper 3 | 2 | 15 | 35 | 50 |
| | 24-ST-364 | IV | Statistics theory paper 4 | 2 | 15 | 35 | 50 |
| 6 | 24-ST-365 | V | Statistics theory paper 5 | 2 | 15 | 35 | 50 |
| | 24-ST-366 | VI | Statistics theory paper 6 | 2 | 15 | 35 | 50 |
| | 24-ST-367 | VII | Statistics Practical Paper IV | 2 | 15 | 35 | 50 |
| | 24-ST-368 | VIII | Statistics Practical Paper V | 2 | 15 | 35 | 50 |
| | 24-ST-369 | IX | Statistics Practical Paper VI | 2 | 15 | 35 | 50 |
| | 24-ST-3610 | X | Skill enhancement course 1 | 2 | 15 | 35 | 50 |
| | 24-ST-3611 | XI | Skill enhancement course 2 | 2 | 15 | 35 | 50 |

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## SEMESTER – I

## PAPER -I

### 22-ST-111: Descriptive Statistics I

**Objectives:**
The main objective of this course is to acquaint students with some basic concepts in Statistics. They will be introduced to some elementary statistical methods for data analysis.

**Course Outcomes (Cos):**
   CO1) Students should be able to recall basic concepts like mean, median, mode which they have learned in school and Junior college.
   CO2) Students will understand the concept of population and sample, various statistical measures such as measures of central tendency, dispersion, skew-ness and kurtosis.
   CO3) Students will be able to describe the association between interrelated qualitative variables.
   CO4) Students will be able to apply all the above mentioned topics in the real life.
   CO5) Students will be able to analyze data collected through survey, sampling, etc.

**Course Content:**
**Unit 1. Introduction to Statistics**                              (2L) **2H**

- Meaning of Statistics as a Science, Importance of Statistics.
- Scope of Statistics: In the field of Industry, Biological sciences, Medical sciences, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology.
- Statistical organizations in India and their functions: CSO, ISI, NSSO, IIPS Devnar, Mumbai, Bureau of Economics and statistics.
- Statistical Heritage (Indian Perspective: i) Dr. V. S. Huzurbazar,
  ii) Dr. P.C. Mahalnobis iii) Dr. P. V. Sukhatme, iv) Dr. C. R. Rao.

**Unit 2. Population and Sample**                              (5L) **4H**

- Types of characteristics and their scale:
  Attributes: Nominal scale, ordinal scale,
  Variables: discrete and continuous variables, interval scale, ratio scale,
- Types of data:
  Primary data, Secondary data, Cross-sectional data, time series data, directional data.
- Notion of a statistical population and sample:

  Finite population, infinite population, homogeneous population and heterogeneous population. Random sample. Methods of sampling (Description only): Simple random sampling with and without replacement (SRSWR and SRSWOR) stratified random sampling, systematic sampling, cluster sampling and two-stage sampling.

## Unit 3.  Summary Statistics:                                                (13L) **12H**

- Presentation of Data, Interpretation of Data from table and graph, Data validation

- Frequency Classification: Raw data and its classification, ungrouped frequency distribution, Sturges' rule, grouped frequency distribution, inclusive and exclusive methods of classification, Open end classes, and relative frequency distribution, cumulative frequency distribution. Histogram and cumulative frequency curves.

- Measures of Central Tendency:
  Concept of central tendency, Statistical averages, characteristics of a good statistical average.
  Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean.
  Geometric Mean (G.M.): Definition, formula, merits and demerits.
  Harmonic Mean (H.M.): Definition. Formula, merits and demerits.
  Order relation between arithmetic mean, geometric mean, harmonic mean
  Weighted Mean: weighted A.M., G.M. and H.M. Real life applications.

- Mode and Median: Definition, formulae (for ungrouped and grouped data), merits and demerits. Empirical relation between mean, median and mode.

- Partition Values: Quartiles, Deciles and Percentiles (for ungrouped and grouped data), Box Plot.
  Situations where one kind of average is preferable to others.

- Measures of Dispersion:
  Concept of dispersion, characteristics of good measure of dispersion.
  Range, Semi-Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits.
  Mean deviation: Definition, merits and demerits, minimality property (without proof), Mean squared deviation: Definition, minimality property of mean squared deviation (with proof),
  Variance and standard deviation: Definition, merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups).
  Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)

## Unit 4. Moments, Skewness and Kurtosis:                                    (8L) **7H**

- Raw moments ($m'_r$) for ungrouped and grouped data. Central moments ($m_r$) for ungrouped and grouped data, Effect of change of origin and scale. Relations between central moments and raw moments, up to 4-th order.

- Concept of symmetry/skewness, positive skewness, negative skewness, Bowley's coefficient of skewness and statement of its range, interpretation using Box plot. Karl Pearson's coefficient of skewness. Measures of skewness based on moments ($\widehat{\beta_1}, \widehat{\gamma_1}$)

- Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions. Measures of kurtosis based on moments ($\widehat{\beta_2}, \widehat{\gamma_2}$), Properties of $\widehat{\beta_1}$ and $\widehat{\beta_2}$:
  i) $\widehat{\beta_2} \geq 1$  ii) $\widehat{\beta_2} \geq \widehat{\beta_1} + 1$

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**Unit 5**. **Theory of Attributes:**                                              (8L) **5H**

- Attributes: Concept, classification, notion of manifold classification, dichotomy, concept of Likert scale, order of a class, class- frequency, positive class-frequency, negative class frequency, ultimate class frequency, relationship among different class frequencies (up to three attributes) using dot operator, fundamental set of class frequencies.
- Consistency of data up to 2 attributes.
- Concepts of independence and association of two attributes. Yule's
- Coefficient of association (Q), $-1 \leq Q \leq 1$, interpretation.
- Mosaic plot-Representation of classification of two attributes.

**Recommended Books:**

| Sr. No. | Title of the book | Name of Author | Publication |
|---------|-------------------|----------------|-------------|
| 1 | Programmed Statistics | Agarwal B. L. | Second Edition, New Age International Publishers, New Delhi.(2003) |
| 2 | Glimpses of India's Statistics Heritage | Ghosh, J. K., Mitra, S. K., Parthsarthi, K. R. | Wiley publishing Co. (1993) |
| 3 | Fundamentals of Statistics | Goon, A. M., Gupta M. K. and Dasgupta, B. | Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd. Calcutta. (1983). |
| 4 | Fundamentals of Mathematical Statistics | Gupta, S. C. and Kapoor, V. K. | Eighth Edition, Sultan Chand and Sons Publishers, New Delhi (1983) |
| 5 | Fundamentals of Applied Statistics | Gupta, S. C. and Kapoor, V. K. | Third Edition, Sultan Chand and Sons Publishers, New Delhi (1997) |
| 6 | Introductory Statistics | Neil A. Weiss | Tenth Edition, Pearson. (2016) |
| 7 | Statistics Made it Simple: Do it yourself on PC | Sarma, K. V. S | Prentce Hall of India, New Delhi.(2001) |
| 8 | Statistical Methods | Snedecor G. W. and Cochran W. G | Eighth Ed. East- West Press. (1989) |
| 9 | Probability and Statistics for Engineers and Scientists | Raymond Myers and Ronald E. Walpole | Pearson Education (2007) |

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## 22-ST–112: Discrete Probability and Probability Distributions I

**Objectives:**

The main objective of this course is to introduce to the students the basic concepts of probability, axiomatic theory of probability, concept of random variable, probability distribution (univariate and bivariate) discrete random variables, expectation and moments of probability distribution.

**Course Outcomes (Cos):**
By the end of the course students are expected to be able to:
   CO1) Students can recall basic concepts of Probability.
   CO2) Students will understand the concept of probability distribution of random variable (one or two dimensional) in the given situation.
   CO3) Students will be able to apply above concepts in real life.
   CO4) Students will be able to distinguish between random and non-random experiments.

**Course Content:**
**Unit 1. Basics of Probability**                                             (6L) **4H**
- Experiments/Models, classification of experiment as deterministic and non-deterministic/ random experiment.
- Concept of statistical regularity.
- Definitions of - Sample space, event, elementary event, complement of an event, certain event, impossible event
- Types of sample space: finite sample space, countably infinite sample space, equi-probable and non-equiprobable sample space
- Concept of occurrence of an event.
- Algebra of events and its representation in set theory notation. Occurrence of following events.
   (i)   at least one of the given events,
   (ii)  none of the given events,
   (iii) all of the given events,
   (iv) mutually exclusive events,
   (v)  mutually exhaustive events,
   (vi) exactly one event out of the given events.
- Classical definition of probability and its limitations.
- Probability model, probability of an event.
- Axiomatic definition of probability.
- Theorems and results on probability with proofs based on axiomatic definition such as
   (i)   $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.
   (ii)  Generalization $P(A \cup B \cup C)$
   (iii) $0 \le P(A) \le 1$
   (iv) $P(A) + P(A') = 1$
   (v)  $P(\Phi) = 0$
   (vi) $P(A) \le P(B)$ when $A \subset B$
   (vii) Boole's inequality.

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### Unit 2: Conditional Probability and Bayes' Theorem:                    (5L) **4H**
- *Definition of conditional probability of an event. Results on conditional probability.*
- Definition of independence of two events $P(A \cap B) = P(A) \cdot P(B)$
    (i) Pairwise independence
    (ii) Mutual independence for three events
- Multiplication theorem
    (i) $P(A \cap B) = P(A) \cdot P(B|A)$.
    (ii) Generalization to $P(A \cap B \cap C)$.
- Partition of the sample space, prior and posterior probabilities. Proof of Bayes' theorem. Applications of Bayes' theorem in real life. True positive, false positive and sensitivity of test as application of Bayes' theorem.

### Unit 3: Uni-variate Probability Distributions (Defined on Discrete Sample Space):
                                                                              (3L) **2H**
- Concept and definition of a discrete random variable.
- Probability mass function (p. m. f.)
- Cumulative distribution function (c. d. f.), $F(\cdot)$ of discrete random variable, properties of c. d. f.
- Mode and median of a univariate discrete probability distribution.

### Unit 4: Mathematical Expectation (Univariate Random Variable):          (8L) **7H**
- Definition of expectation (Mean) of a random variable, expectation of a function of a random variable, m. g. f. and c. g. f. Properties of m. g. f. and c. g. f.
- Definitions of variance, standard deviation (s. d.) and Coefficient of variation (C.V.) of univariate probability distribution, effect of change of origin and scale on mean, variance and s. d.
- Definition of raw, central and factorial raw moments of univariate probability distributions and their interrelations (without proof).
- Coefficients of skew-ness and kurtosis based on moments.

### Unit 5: Some Standard Discrete Probability Distributions:               (14L) **13H**
- Degenerate distribution (one point distribution): $P(X=c) = 1$, mean and variance.
- Uniform discrete distribution on integers 1 to n: p. m. f., c. d. f., mean, variance, real life situations, comments on mode and median.
- Bernoulli distribution: p. m. f., mean, variance.
- Binomial Distribution: p. m. f., Notation: $X \sim B(n, p)$.
  Recurrence relation for successive probabilities, computation of probabilities of different events, mode of the distribution, mean, variance, m.g.f. and c.g.f. moments, skewness (comments when $p = 0.5$, $p > 0.5$, $p < 0.5$). Situations where this distribution is applicable. Additive property for binomial distribution. Conditional distribution of X given (X+Y) for binomial distribution.
- Hypergeometric distribution:
  Necessity and importance of Hyper-geometric distribution, capture- recapture method, p. m. f., Notation: $X \sim H(N, M, n)$.
  Computation of probability, situations where this distribution is applicable, binomial approximation to hyper-geometric probabilities, statement of mean and variance of the distribution (Derivation is not expected).

**Recommended Books:**

| Sr. No. | Title of the book | Name of Author | Publication |
|---|---|---|---|
| 1 | Programmed Statistics, second edition, | Agarwal B. L. (2003). | New Age International Publishers, New Delhi |
| 2 | Fundamentals of Mathematical Statistics | Gupta, S.C. and Kapoor, V. K. (1983), Eighth Edition | Sultan Chand and Sons Publishers, New Delhi |
| 3 | Introduction to Mathematical Statistics | Hoel P. G. (1971) | John Wiley and Sons, New York |
| 4 | Introduction to Mathematical Statistics | Hogg, R. V. and Craig R.G. (1989). | MacMillan Publishing Co., New York |
| 5 | Introductory Probability and Statistical Applications | Mayer, P. (1972) | Addison Wesley Publishing Co., London. |
| 6 | Introduction to the Theory of Statistics | Mood, A. M. and Graybill, F. A. and Boes D.C. (1974), Ed. 3, | McGraw Hill Book Company |
| 7 | First Course in Probability and Statistics | Rao, VLS Prakash (2008) | New Age International Publishers, New Delhi |
| 8 | A First Course in Probability, | Ross S. (2002), Sixth Edition | Pearson Education, Inc. & Dorling Kindersley Publishing |

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## 22-ST–113 PRACTICAL

**Pre-requisites**: Knowledge of the topics in theory papers I and II.

At the end of this course students will be able to:
- (i)   Use the various graphical and diagrammatic techniques and their interpretation.
- (ii)  Analyze and interpret the data.
- (iii) Compute various measures of central tendency, dispersion, skewness and kurtosis.
- (iv)  use different functions available in Ms-Excel
- (v)   Summarize and analyze the data using computer techniques.

| Sr. No. | Title of the experiment | No. of Practical |
|---|---|---|
| 1 | Diagrammatic representation of statistical data: simple and subdivided bar diagrams, multiple bar diagram, percentage bar diagram, pie diagram using Ms-Excel and manually, | 2 |
| 2 | Graphical representation and interpretation of statistical data: Histogram, frequency curveand ogive curves. Determination of mode and median graphically using Ms-Excel and manually. | 2 |
| 3 | Data representation using tabulation and Attributes (manually) (Mosaic Plot, Heat map using Ms-Excel.). | 2 |
| 4 | Use of random number tables to draw SRSWOR, SRSWR, stratified sample and systematic sample using Ms-Excel and manually. | 2 |
| 6 | Computation of measures of central tendency and dispersion (ungrouped data). Use of an appropriate measure and interpretation of results and computation of partition values using Ms-Excel. | 1 |
| 7 | Computation of measures of central tendency and dispersion (grouped data). Use of an appropriate measure and interpretation of results and Computation of partition values using Ms-Excel. | 1 |
| 8 | Measures of skewness and kurtosis, Box plot using Ms-Excel. | 1 |
| 9 | Survey Report(Use Likert Scale) | 4 |
| Total | | **15** |

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<p align="center">**SEMESTER – II**</p>

<p align="center">**PAPER -I**</p>

<p align="center">## 22-ST-121: Descriptive Statistics II</p>

**Objectives:**

The main objective of this course is to acquaint students with bivariate data. They will be introduced to some methods of analysis of bivariate data.

**Course Outcomes (COs):**

CO1)  Students will recall various statistical sampling methods and how to classify and represent that data graphically.

CO2) Students will go through statistical measures such as Karl Pearson's correlation coefficient to estimate relationship among variables.

CO3) Students will be able to describe the correlation between interrelated variables and also able to find appropriate regression equation among the variables.

CO4) They will understand how to construct mathematical equations to display the relationship among variables using line fitting and curve fitting methods.

CO5) Students will be able to apply correlation, Regression and index numbers techniques in the real life.

CO6) The students are expected start using some statistical software and verify their theoretical knowledge about different statistical entities and computations during practical sessions.

**Course Content:**

**Unit1: Correlation:**                                                        (10L) 9H

- Bivariate data, Scatter diagram and interpretation, correlogram.
- Concept of correlation between two variables, positive correlation, negative correlation, no correlation.
- Covariance between two variables ($m_{11}$): Definition, computation, effect of change of origin and scale.
- Karl Pearson's coefficient of correlation (r): Definition, computation for ungrouped data and interpretation. Properties: (i) $-1 \le r \le 1$(with proof), (ii) Effect of change of origin and scale (with proof).
- Spearman's rank correlation coefficient: Definition, derivation of formula, computation and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)

**Unit2: Fitting of Line (Regression Line):**                               (12L) **11H**

- Concept of dependent and independent variables.
- Identification of response and predictor variables and relation between them.
- Meaning of regression, connection between correlation and regression,
- Simple linear regression model: $Y=a+bX +\in$ .Fitting of line $Y= a + bX$. Estimation of 'a' and 'b' using least square method and interpretation of 'b' as regression coefficient. Explained and unexplained variation, coefficient of determination, standard error of an estimate of line of regression, relation between regression coefficients and correlation coefficient.
- Residual plots and its interpretation.

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### Unit 3: Curve Fitting:             (6L) **4H**

- Necessity and importance of drawing curves
  Fitting of second degree curve $Y = a + b X + cX^2$,
- Fitting of exponential curves of the type $Y = a\, b^X$ and $Y = aX^b$.
- In all these curves constants a, b, c are found out by the method of least squares. (Justification via determinant of matrix of second derivative/second derivative test).

### Unit 4. Index Numbers:             (8L) 6H

- Introduction and scope of Index Numbers. Various types of Index Numbers like Human Development Index, Happiness Index, BSE sensitivity Index.
- Definition and Meaning.
- Problems/considerations in the construction of index numbers.
- Simple and weighted price index numbers based on price relatives.
- Simple and weighted price index numbers based on price aggregates.
- Laspeyre's, Paasche's and Fisher's Index numbers.
- Consumer price index number: Methods of construction of consumer price index number – (i) Family budget method (ii) Aggregate expenditure method
- Shifting of base, splicing, deflating and purchasing power.

### Recommended Books:

| Sr. No. | Title of the book | Name of Author | Publication |
|---------|-------------------|----------------|-------------|
| 1 | Programmed Statistics | Agarwal B. L. | Second Edition, New Age International Publishers, New Delhi.(2003) |
| 2 | Glimpses of India's Statistics Heritage | Ghosh J. K., Mitra, S. K., Parthsarthi, K. R. | Wiley publishing Co. (1993) |
| 3 | Fundamentals of Statistics | Goon, A. M., Gupta, M. K. and Dasgupta, B. | Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd, Calcutta.(1983). |
| 4 | Fundamentals of Mathematical Statistics | Gupta, S. C. and Kapoor, V. K. | Eighth Edition, Sultan Chand and Sons Publishers, New Delhi (1983) |
| 5 | Fundamentals of Applied Statistics | Gupta, S. C. and Kapoor, V. K. | Third Edition, Sultan Chand and Sons Publishers, New Delhi (1997) |
| 6 | Introductory Statistics | Neil A. Weiss | Tenth Edition, Pearson. (2016) |
| 7 | Statistics Made it Simple: Do it yourself on PC | Sarma, K. V. S | Prentce Hall of India, New Delhi.(2001) |
| 8 | Statistical Methods | Snedecor G. W. and Cochran W. G | Eighth Ed. East- West Press. (1989) |

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## SEMESTER – II

## PAPER –II

### 22-ST –112: Discrete Probability and Probability Distributions II

**Objectives:**
The main objective of this course is to introduce to the students some discrete Distributions and its application in real life.

**Course Outcomes (COs):**
   CO1)  Students will recall concept of discrete random variable and continuous random variable.
   CO2) Students will go through statistical measures such as Karl Pearson's correlation coefficient to estimate relationship among variables.
   CO3) Students will study properties of these distributions as well as interrelation between them.
   CO4) They will learn various Standard Discrete Probability Distributions.
   CO5) Students will be able to apply standard discrete probability distribution to different situations.

**Course Content:**

**Unit 1: Some Standard Discrete Probability Distributions:**                                    (16 L) 13H
   - Poisson distribution: p. m. f. of the distribution, Notation: $X \sim P(m)$.
   Mean, variance, m. g. f. and c. g. f.
   Real life situation where this distribution is applicable.
   Additive property for Poisson distribution.
   Conditional distribution of X given (X+Y).
   - Geometric distribution: p. m. f. of the distribution with support (0, 1, 2…)
      p. m. f. of the distribution with support (1, 2...)
   Notation: $X \sim G(p)$,
   Mean, variance, m. g. f. and c. g. f.
   Situations where this distribution is applicable. Lack of memory property.

**Unit 2:  Bivariate Discrete Probability Distribution:**                                    (6L) 5H
   - Definition of two-dimensional discrete random variable, joint p. m. f. distribution function and their properties.
   - Concept of identically distributed r. v s.
   - Computation of probabilities of events in bivariate probability distribution.
   - Concepts of marginal and conditional probability distributions.
   - Independence of two discrete random variables based on joint and marginal p. m. f.

**Unit 3: Mathematical Expectation (Bivariate Random Variable)**                                    (14L) 12H
   - Definition of raw ($\mu'_r$) and central moments ($\mu_r$), m. g. f., c. g. f.
   - Theorems on expectations of sum and product of two jointly distributed random variables.
   - Conditional expectation, conditional variance
   - Definition of covariance, coefficient of correlation, independence and uncorrelatedness of two variables.
   - Expectation and Variance of linear combination of variables: aX +bY+ c.

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**Recommended Books:**

| Sr. No. | Title of the book | Name of Author | Publication |
|---------|-------------------|----------------|-------------|
| 1 | Programmed Statistics | Agarwal B. L. (2003), second edition | New Age International Publishers, New Delhi |
| 2 | Fundamentals of Mathematical Statistics | Gupta, S.C. and Kapoor, V. K. (1983), Eighth Edition | Sultan Chand and Sons Publishers, New Delhi. |
| 3 | Introduction to Mathematical Statistics | Hoel P. G. (1971) | John Wiley and Sons, New York |
| 4 | Introduction to Mathematical Statistics | Hogg, R. V. and Craig R.G. (1989). | MacMillan publishing Co., New York. |
| 5 | Introductory Probability and Statistical Applications | Mayer, P. (1972) | Addison Wesley Publishing Co., London |
| 6 | Introduction to the Theory of Statistics, | Mood, A. M. and Graybill, F. A. and Boes D.C. (1974), Ed 3 | McGraw Hill Book Company. |
| 7 | A First Course in Probability | Ross S. (2002)., Sixth Edition | Pearson Education, Inc. & Dorling Kindersley Publishing, Inc. |

**Reference Websites for Paper I and Paper II:**
1. www.stats.unipune.ac.in (100 Data sets for Statistics Education by Dr. Anil P. Gore, Dr. Mrs. S. A. Paranjape and Madhav B. Kulkarni available in ISPS folder).
2. www.freestatistics.tk(National Statistical Agencies)
3. www.psychstat.smsu.edu/sbk00.htm(Onlinebook)
4. www.bmj.bmjournals.com/collections/statsbk/index.shtml
5. www.statweb.calpoly.edu/bchance/stat-stuff.html
6. www.amstat.org/publications/jse/jse-data-archive.html(International journal on teaching and learning of statistics)
7. www.amstat.org/publications/chance(Chancemagazine)
8. www.statsci.org/datasets.html(Datasets)
9. www.math.uah.edu/stat(Virtual laboratories in Statistics)
10. www.amstat.org/publications/stats(STATS : the magazine for students of Statistics)
11. www.stat.ucla.edu/cases(Case studies in Statistics).
12. www.statsoft.com
13. www.statistics.com
14. www.indiastat.com
15. www.unstat.un.org
16. www.stat.stanford.edu
17. www.statpages.net
18. www.wto.org
19. www.censusindia.gov.in
20. www.mospi.nic.in
21. www.statisticsofindia.in

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**SEMESTER – II**

**PAPER –III**

## 22-ST–123: PRACTICALS

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**Pre-requisites**: Knowledge of the topics in theory papers I and II.
   At the end of this course students will be able:
   (i)   to compute correlation coefficient, regression coefficients,
   (ii)  to compute probabilities of bivariate distributions,
   (iii) to fit binomial and Poisson distributions
   (iv)  to draw random samples from Poisson and binomial distributions.

| Sr. No. | Title of the experiment | No. of Practical |
|---|---|---|
| 1 | Scatter diagram, correlation coefficient (ungrouped data), Correlogram. Fitting of line of regression (Y on X), Residual Plots and Interpretation using MS-Excel. | 1 |
| 2 | Fitting of second degree curve, exponential curve of type $Y = ab^x$, $Y = ax^b$ using MS-Excel. | 1 |
| 3 | Fitting of Binomial distribution and Poisson distribution and computation of expected frequencies using MS-Excel. | 1 |
| 4 | Fitting of Binomial distribution and Poisson distribution and computation of expected frequencies using manually. | 1 |
| 5 | Applications of Binomial &hyper geometric distributions. | 1 |
| 6 | Applications of Poisson & geometric distributions. | 1 |
| 7 | Model sampling from Poisson and Binomial distributions using MS-Excel and manually. | 2 |
| 8 | Index numbers-I | 1 |
| 9 | Index numbers-II | 1 |
| 10 | Problems based on Bivariate Probability distributions. | 1 |
| 11 | Project/ Field Visit | 4 |
| **Total** | | **15** |

**Notes:**
  1. For project, a group of maximum 8 students will be allowed.
  2. All the students in a group should be given equal marks for project.

  3. Different data sets from newspapers, internet, and magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt. Students must complete all the practical to the satisfaction of the teacher concerned.
  4. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

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