University of Pune

Three Year B. Sc. Degree Program in Statistics

Syllabus for F.Y.B.Sc. Statistics / Statistical Techniques
(With effect from Academic Year 2013-2014)

Submitted by

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

2) Preamble to the syllabus: The word *Statistics* is used in different ways in different contexts. To a cricket fan, Statistics is the information about runs scored or wickets taken by a player. To the manager of a manufacturing unit, Statistics may be the information about the process control. To a medical researcher investigating the effects of a new drug, Statistics are evidence of research efforts. To a college student, Statistics are the grades or marks scored in a course. Thus, in all these illustrations Statistics word refers to quantitative data in the area under study. Statistics as a subject is an important branch of knowledge and is devoted to various techniques of collection, presentation, analysis and interpretation of data. It is a science of learning from data.

Statistics provides tools for making decisions when conditions of uncertainty prevail. Hence these tools and techniques are used in almost all fields. Statistics is indispensable for people working in fields like agriculture, business, management, economics, finance, insurance, education, biotechnology and medical science etc. Since last two decade, with the help of computers large amount of data can be handled and more sophisticated statistical techniques can be used in an effective manner. Knowledge of different aspects of Statistics has become crucial. There is a continuous demand for statisticians in every field – education, industry, software 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.

Up to higher secondary school, students are mostly exposed to descriptive statistics. These techniques are briefly reviewed but the emphasis in degree course is on inferential statistics. At the end of the degree course a student is expected to apply the statistical tools to real life data and analyze it.

3) Introduction: B. Sc. in Statistics program is of three years duration, with semester pattern for the second and third year and annual examination pattern for the first year. 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 Statistics at the First year of the three-year B.Sc. course may be allowed to offer Statistical Techniques as one of their subjects in the second year of the three-year B.Sc. in place of Statistics. Students offering Statistical Techniques at the first year of the three-year B.Sc. course may be allowed to offer Statistics as one of their subjects in the second year of the three-year B.Sc. course in place of Statistical Techniques provided they satisfy other requirements regarding subject combinations, if any.

At **first year of under-graduation**, students will be given the basic information that includes – methods of data representation and summarization. Correlation and regression are the tools that are frequently used in statistical analysis. These topics are studied in Paper I. Further they are introduced to probability and different discrete probability distributions along with applications. Relevant experiments on these topics will be included in practical course.

At **second year of under-graduation,** students are expected to study various probability distributions and its applications to real life situations. 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.

At **third year of under-graduation**, six theory papers deal with theoretical as well as applied aspect of statistics. Two papers each are included on distribution theory and parametric inference. Study of sampling methods is essential part which is covered in sampling theory paper. In Design of Experiments paper, various designs used in agriculture and industry are studied. Papers of applied nature, like medical statistics, actuarial statistics, time series, R software and operations research will also be introduced. There are three practical courses based on core courses. In one of the practical courses, project component will be introduced.

4) Eligibility

1. First Year B.Sc.:
    Higher Secondary School Certificate (10+2) or its equivalent Examination with English and Mathematics; and two of the science subjects such as Physics, Chemistry, Biology, Geography, Geology, etc.

2. Second Year B.Sc.:
     Keeping terms of First Year of B. Sc. with Statistics as one of the subjects.

3. Third Year B. Sc.:
     Student shall clear all First Year B. Sc. Statistics courses and keeping terms of Second Year of B. Sc. with Statistics as one of the subjects.

  Admissions will be given as per the selection procedure / policies adopted by the respective college keeping in accordance with conditions laid down by the University of Pune. Reservation and relaxation will be as per the Government rules.

5) Examination

A) Pattern of Examination: Pattern of examination and of the question paper is specified below in item 6.

B) Standard of Passing

    i.   In order to pass in the first year theory examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks must be obtained in the University Theory Examination.)

    ii.   In order to pass in the Second Year and Third Year theory examination, the candidate has to obtain 20 marks out of 50 in each course of each semester. (Minimum 16 marks must be obtained in the University Theory Examination.)

    iii.   In order to pass in practical examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks must be obtained in the University Examination.)

C) ATKT Rules: As per university rules.

D) Award of Class

The class will be awarded to the student on the aggregate marks obtained during the second and third year in the Principal subject only. The award of the class shall be as follows:

1	Aggregate 70% and above	First Class with Distinction
2	Aggregate 60% and more but less than 70%	First Class
3	Aggregate 55% and more but less than 60%	Higher Second Class
4	Aggregate 50% and more but less than 55%	Second Class
5	Aggregate 40% and more but less than 50%	Pass Class
6	Below 40%	Fail

E) External Students: There shall be no external students.

F) Pattern of question paper: It is specified below in item 6.

G) Verification/Revaluation: As per the University rules.

6 a, b, c) 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

Paper	Course Title	Marks	Lectures
Paper - I	Descriptive Statistics	100	Three lectures / week per paper (Total 36 lectures / paper per term)
Paper - II	Discrete Probability and Probability Distributions	100	
Paper–III (Practical)	Practical Course	100	Four lectures / week / per batch (Total 96 – Term I & II)

Examination Pattern

Theory paper: University Examination – 80 marks (at the end of 2nd term)
                 Internal Examination   – 20 marks
Practical course: University Examination – 80 marks (at the end of 2nd term)
                 Internal Examination   – 20 marks

Theory examination will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks. The pattern of question papers shall be:

Question 1   8 sub-questions, each of 2 marks; answerable in 2 -3 lines and based on entire syllabus.

Question 2 & 3   4 out of 6 – short answer type questions; answerable in 6 – 8 lines, each of 4 marks.

Question 4   2 out of 4 – long answer type questions; answerable in 12 – 16 lines, each of 8 marks.

Question 5   1 out of 2 –essay / long answer type question; answerable in 25 – 30 lines, each of 16 marks.

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks per paper for each term. The written test shall comprise of objective type questions – multiple choice questions, True / False, definitions, tricky computational problems with minimum calculations.

Practical Examination: Practical examination shall be conducted by the respective college at the end of the academic year. The duration of the examination is 3 hours. Additional 10 minutes are given for viva. Students should complete all practicals to the satisfaction of the teacher concerned. Students should produce the journal along with certificate (signed by head of the department) at the time of practical examination. Structure of the evaluation of practical paper:

(A) Continuous internal evaluation:
    (i) Journal   10 marks
    (ii) Project (report & viva on project)   10 marks

(B) Annual Practical Examination:
    (i) Questions using MS-Excel   10 marks
    (ii)Questions using calculator   60 marks
    (iii) Viva   10 marks
                              Total: (A) + (B) = 100 marks

There shall be two examiners per batch of 15 students for the practical examination.

Setting of question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Structure of S. Y. B. Sc. Statistics

	Paper	Course Title	Marks	Lectures
Semester I	ST- 211	Theory I	50	Four lectures/week per paper (Total 48 lectures/paper per semester)
	ST- 212	Theory II	50	
Semester II	ST - 221	Theory I	50	
	ST - 222	Theory II	50	
Semester I & II	ST- 223	Practical Course	100	Four lectures/week /per batch (Total 96 in semester I & II)

Examination Pattern

  Theory course:
  University Examination – 40 marks (at the end of each semester)
  Internal Examination   – 10 marks

  Practical course:
  University Examination – 80 marks (at the end of 2nd semester)
  Internal Examination   – 20 marks

Theory examination will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks. The pattern of question papers shall be as follows.

Question 1	10 sub-questions, each of 1 mark; objective type and based on entire syllabus.
Question 2 & 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines.
Question 4	1 out of 2 – long answer type questions; answerable in 20 – 25 lines, each of 10 marks.

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks per paper for each semester. The written test shall comprise of objective type questions – Multiple choice questions, True / False, definitions, tricky computational problems with minimum calculations. Different sets of question papers may be given in the same class-room.

Practical Examination: The duration of the examination is 3 hours and 30 minutes. Students should complete all practicals to the satisfaction of the teacher concerned. Students should produce the journal along with certificate (signed by head of the department) at the time of practical examination.

Structure of the evaluation of practical paper

(A) Continuous internal evaluation:
    (i) Journal   10 marks
    (ii) Viva   10 marks

(B) Annual Practical Examination:
    (i) Questions using MS-Excel   10 marks
    (ii) Questions using calculator   60 marks
    (iii) Viva   10 marks
                                 Total: (A) + (B) = 100 marks

There shall be two examiners per batch of size 12/15 for the practical examination. One of the examiners will be external.

Setting of question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Structure of T. Y. B. Sc. Statistics

Theory Papers

	Paper	Paper Title	Marks	Lecturers
Semester III	ST 331	Theory I	50	Four lectures per week per paper per batch (Total 48 lectures per paper per semester)
	ST 332	Theory II	50	
	ST 333	Theory III	50	
	ST 334	Theory IV	50	
	ST 335	Theory V	50	
	ST 336	Theory VI (Elective)	50	
Semester IV	ST 341	Theory I	50	
	ST 342	Theory II	50	
	ST 343	Theory III	50	
	ST 344	Theory IV	50	
	ST 345	Theory V	50	
	ST 346	Theory VI (Elective)	50	

Note: In semesters III and IV, a student will opt for one elective paper. A list of elective papers will be provided when the syllabus for the third year is revised.

Structure of Practical Courses

	Paper	Course title	Marks	
Semester III & IV	ST 347	Practical paper – I	100	Four lectures per week per batch per paper (Total 96 hours per paper per semester)
	ST 348	Practical paper – II	100	
	ST 349	Practical paper – III	100	

Theory papers
University Examination – 40 marks (at the end of each semester)
Internal Examination – 10 marks

Practical course
University Examination – 80 marks (at the end of 2nd semester)
Internal Examination – 20 marks

Theory examination will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks. The pattern of question papers shall be as follows.

Question 1	10 sub-questions, each of 1 mark; objective type and based on entire syllabus.
Question 2 & 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines.
Question 4	1 out of 2 – long answer type questions; answerable in 20 – 25 lines, each of 10 marks.

Internal examination: Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test, 10 marks per paper for each semester. The written test shall comprise of objective type questions – Multiple Types Questions, True / False, Definitions, Tricky computational problems with minimum calculations. Different sets of question papers may be given in the same class-room.

Practical Examination: Nature of practical papers

(A) Continuous internal evaluation
    (i) Journal   10 marks
    (ii) Viva   10 marks
(B) Annual Practical examination:
    (i)Questions using calculator (2 questions out of 4)   70 marks
    (ii) Viva   10 marks
                           Total: (A) + (B) = 100 marks

Notes
1. Total duration of practical examination for each course will be 3 hours and 30 minutes. There shall be two examiners per batch of 12 students for each practical course and one of the examiners will be external.

2. To perform and complete the practical, it is necessary to have computing facility. So there should be sufficient number of computers, UPS, printer and scientific, non programmable calculators and statistical tables in the laboratory.

3. In order to acquaint the students with applications of statistical methods in various fields such as industries, agricultural sectors, government institutes, etc. **at least one Study Tour for T.Y. B.Sc. Statistics students must be arranged**.

4. Use of scientific calculators and statistical tables is allowed for **theory** as well as **practical** examination.

Setting of question papers: Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

6d) Medium of Instruction: The medium of instruction for the course shall be English. The syllabi of courses of state and central boards of higher secondary level were reviewed to avoid repetitions.

7) Equivalence of Previous Syllabus: No equivalence required at F. Y. B. Sc. level, the course titles are same as previous syllabus.

8) University Terms: Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

9) and 10) Subject wise Detailed Syllabus of F.Y.B.Sc. Statistics/Statistical Techniques and Recommended Books

Paper I: Descriptive Statistics

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 of analysis of data. At the end of this course students are expected to be able,
- (i) to compute various measures of central tendency, dispersion, skewness and kurtosis.
- (ii) to analyze data pertaining to attributes and to interpret the results.
- (iii) to compute the correlation coefficient for bivariate data and interpret it.
- (iv) to fit linear, quadratic and exponential curves to the bivariate data to investigate relation between two variables.
- (v) to fit linear regression model to the bivariate data
- (vi) to compute and interpret various index numbers.

1. **Introduction to Statistics**   (2L)
   - 1.1 Meaning of Statistics as a Science.
   - 1.2 Importance of Statistics.
   - 1.3 Scope of Statistics: In the field of Industry, Biological sciences, Medical sciences, Economics, Social Sciences, Management sciences, Agriculture, Insurance, Information technology, Education and Psychology.
   - 1.4 Statistical organizations in India and their functions: CSO, ISI, NSS, IIPS (Devnar, Mumbai), Bureau of Economics and statistics.

2. **Population and Sample**   (4L)
   - 2.1 Types of characteristics:
     Attributes: Nominal scale, ordinal scale,
     Variables: Interval scale, ratio scale, discrete and continuous variables,
     difference between linear scale and circular scale
   - 2.2 Types of data:
     (a) Primary data, Secondary data
     (b) Cross-sectional data, time series data, directional data.

2.3 Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample

2.4 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.

3. Summary Statistics.   (12L)

Review / Revision of Presentation of Data

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

3.2 Measures of Central Tendency

Review / Revision of following topics: Concept of central tendency of statistical data, 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.
Mode and Median: Definition, formulae (for ungrouped and grouped data), merits and demerits. Empirical relation between mean, median and mode (without proof).
Topics to be taught in detail:
Partition Values: Quartiles, Deciles and Percentiles (for ungrouped and grouped data), Box Plot.
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.
Situations where one kind of average is preferable to others.

3.3 Measures of Dispersion

Review / Revision of following topics:
Concept of dispersion, characteristics of good measure of dispersion.
Range, Semi-interquartile range (Quartile deviation): Definition, merits and demerits, Mean deviation: Definition, merits and demerits, minimality property (without 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).
Topics to be taught in detail:
Mean squared deviation: Definition, minimality property of mean squared deviation (with proof), Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)

4. Moments, Skewness and Kurtosis   (9L)

4.1 Raw moments (m'_r) for ungrouped and grouped data.

4.2 Central moments (m_r) for ungrouped and grouped data, Effect of change of origin and scale.

4.3 Relations between central moments and raw moments, upto 4-th order (without proof).

4.4 Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution.

4.5 Bowley's coefficient of skewness : Bowley's coefficient of skewness lies between −1 to 1 (with proof), interpretation using Box plot.

4.6 Karl Pearson's coefficient of skewness.

4.7 Measures of skewness based on moments (β_1, γ_1).

4.8 Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions.

4.9 Measures of kurtosis based on moments (β_2, γ_2).

5. Theory of Attributes   (9L)

5.1 Attributes: Concept of a Likert scale, classification, notion of manifold classification, dichotomy, class- frequency, order of a class, positive class-frequency, negative class frequency, ultimate class frequency, relationship among different class frequencies (up to three attributes), and dot operator to find the relation between frequencies, fundamental set of class frequencies.

5.2 Consistency of data upto 2 attributes.

5.3 Concepts of independence and association of two attributes.

5.4 Yule's coefficient of association (Q), $-1 \le Q \le 1$, interpretation.

End of First Term

6. Correlation   (10L)

6.1 Bivariate data, Scatter diagram and interpretation.

6.2 Concept of correlation between two variables, positive correlation, negative correlation, no correlation.

6.3 Covariance between two variables (m_{11}) : Definition, computation, effect of change of origin and scale.

6.4 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).

6.5 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.)

7. Fitting of curves to the bivariate data   (9L)

7.1 Fitting of line (Y = a + b X),

7.2 Fitting of second degree curve (Y = a + b X + c X^2),

7.3 Fitting of exponential curves of the type $Y = a b^X$ and $Y = aX^b$.

In all these curves parameters are estimated by the method of least squares.

8. Linear Regression Model (9L)
8.1 Meaning of regression, difference between correlation and regression,
8.2 Concept of error in regression, error modeled as a continuous random variable. Simple linear regression model: $Y = a + bX + \varepsilon$, where ε is a continuous random variable with $E(\varepsilon) = 0$, $V(\varepsilon) = \sigma^2$. Estimation of a, b by the method of least squares. Interpretation of parameters. Statement of the estimator of σ^2.
8.3 Concept of residual, plot of residual against χ, concept of coefficient of determination.

9 Index Numbers (8L)
9.1 Introduction.
9.2 Definition and Meaning.
9.3 Problems/considerations in the construction of index numbers.
9.4 Simple and weighted price index numbers based on price relatives.
9.5 Simple and weighted price index numbers based on aggregates.
9.6 Laspeyre's, Paasche's and Fisher's Index numbers.
9.7 Consumer price index number: Considerations in its construction. Methods of construction of consumer price index number - (i) family budget method (ii) aggregate expenditure method.
9.8 Shifting of base, splicing, deflating, purchasing power.
9.9 Description of the BSE sensitivity and similar index numbers.

Recommended Books:

1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
2. Draper, N. R. and Smith, H. (1998). Applied Regression Analysis Third Edition, John Wiley and Sons
3. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition,The World Press Pvt. Ltd., Calcutta.
4. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.
6. Freund, J. E. (1977). Modern Elementary Statistics. Fourth Edition, Prentice Hall of India Private Limited, New Delhi.
7. Montgomery, D. C; Peck, E. A.; Vining, G. G. (2006). Introduction to Linear Regression Analysis, John Wiley and Sons
8. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, New Delhi.
9. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, New Delhi.
10. Snedecor G. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. East-West Press.

Paper II: Discrete Probability and Probability Distributions

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. By the end of the course students are expected to be able

    (i) to distinguish between random and non-random experiments.
    (ii) to find the probabilities of events.
    (iii) to obtain a probability distribution of random variable (one or two dimensional) in the given situation, and
    (iv) to apply standard discrete probability distribution to different situations.

1. Review of probability, conditional probability, independence   (6L)

    1.1 Experiments/Models, Ideas of deterministic and non-deterministic models. Random Experiment, concept of statistical regularity.
    1.2 Definitions of - (i) Sample space, (ii) Discrete sample space: finite and countably infinite, (iii) Event, (iv) Elementary event, (v) Complement of an event. (vi) Certain event (vii) Impossible event
    1.3 Concept of occurrence of an event.
    1.4 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.
    1.5 Classical definition of probability and its limitations.
    1.6 Probability model, probability of an event, equiprobable and non-equiprobable sample space,
    1.7 Axiomatic definition of probability.
    1.8 Definition of conditional probability of an event.
    1.9 Definition of independence of two events $P(A \cap B) = P(A) \cdot P(B)$
    1.10 Pairwise independence and mutual independence for three events
    1.11 Multiplication theorem $P(A \cap B) = P(A) \cdot P(B|A)$.
        Generalization to $P(A \cap B \cap C)$.

2. Bayes' Theorem   (3L)

    2.1 Partition of the sample space
    2.2 Proof of Bayes' theorem. Applications of Bayes' theorem in real life

3. Univariate Probability Distributions (Defined on Discrete Sample Space)
(4 L)
   3.1 Concept and definition of a discrete random variable.
   3.2 Probability mass function (p.m.f.) and cumulative distribution function (c.d.f.), F(·) of discrete random variable, properties of c.d.f..
   3.3 Mode and median of a univariate discrete probability distribution.

4. Mathematical Expectation (Univariate Random Variable)   (8 L)
   4.1 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.
   4.2 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.
   4.3 Definition of raw, central and factorial raw moments of univariate probability Distributions and their interrelations **(**without proof).
   4.4 Coefficients of skewness and kurtosis based on moments.

5. Some Standard Discrete Probability Distributions - I   (15 L)
   5.1 Degenerate distribution (one point distribution), P(X=c) =1, mean and variance.
   5.2 Uniform discrete distribution on integers 1 to n: p.m.f., c.d.f., mean, variance, real life situations, comments on mode and median.
   5.3 Bernoulli Distribution: p.m.f., mean, variance.
   5.4 Binomial Distribution: p.m.f.

$$p(x) = \binom{n}{x} p^x q^{n-x}; x = 0, 1, \dots, n, 0 < p < 1, q = 1 - p$$
$$= 0 \; otherwise$$

Notation : X ~ 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.
   5.5 Hypergeometric Distribution : p.m.f.,

$$p(x) = \frac{\binom{M}{x}\binom{N-M}{n-x}}{\binom{N}{n}} \; x = 0, 1, \dots, \min\{M, n\} \; ,$$
$$= 0 \; otherwise$$

Notation : X ~ H(N,M,n).
Computation of probability, situations where this distribution is applicable, binomial approximation to hypergeometric probabilities, mean and variance of the distribution.
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End of the First Term

6. Some Standard Discrete Probability Distributions - II   (16L)
   6.1 Poisson distribution: Notation : X ~ P(m).

$$p(x) = \frac{e^{-m}m^x}{x!} \ , x = 0,1,2,\ldots, m > 0$$

m.g.f. and c.g.f. Moments, mean, variance, skewness and kurtosis.
Situations where this distribution is applicable.

6.2 Geometric distribution: Notation: X ~ G(p),
Geometric distribution on support (0, 1, 2, ...,) with p.m.f. $p(x) = pq^x$.
Geometric distribution on support (1, 2, ...) with p.m.f. $p(x) = pq^{x-1}$.
$0 < p < 1$, $q = 1 - p$.
Mean, variance, m.g.f. and c.g.f. Situations where this distribution is applicable.

7. Bivariate Discrete Probability Distribution   (6L)
7.1 Definition of two-dimensional discrete random variable, its joint p.m.f. and its distribution function and their properties, concept of identically distributed r.vs.
7.2 Computation of probabilities of events in bivariate probability distribution.
7.3 Concepts of marginal and conditional probability distributions.
7.4 Independence of two discrete random variables based on joint and marginal p.m.f.s

8. Mathematical Expectation (Bivariate Random Variable)   (14L)
8.1 Definition of raw and central moments, m.g.f, c.g.f.
8.2 Theorems on expectations of sum and product of two jointly distributed random variables.
8.3 Conditional expectation.
8.4 Definitions of conditional mean and conditional variance.
8.5 Definition of covariance, coefficient of correlation, independence and uncorrelatedness of two variables.
8.6 Variance of linear combination of variables Var(aX + bY).
8.7 Additive property for binomial and Poisson distributions.
8.8 Introduction of negative binomial distribution as sum of k i.i.d. geometric random variables. Statement of p.m.f., mean and variance.
8.9 Conditional distribution of X given (X+Y) for binomial and Poisson distributions.
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Recommended Books:

1. Agarwal B. L. (2003). Programmed Statistics, second edition, New Age International Publishers, New Delhi.
2. Gupta, S.C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
3. Hoel P. G. (1971). Introduction to Mathematical Statistics, John Wiley and Sons, New York.
4. Hogg, R. V. and Craig R. G. (1989). Introduction to Mathematical Statistics, Ed. 4. MacMillan Publishing Co., New York.
5. Mayer, P. (1972). Introductory Probability and Statistical Applications, Addison Wesley Publishing Co., London.

6. Mood, A. M. and Graybill, F. A. and Boes D.C. (1974). Introduction to the Theory of Statistics, Ed. 3, McGraw Hill Book Company.
7. Ross S. (2002). A First Course in Probability, 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. Paranjpe and Madhav B. Kulkarni available in ISPS folder).
2. www.freestatistics.tk (National Statistical Agencies)
3. www.psychstat.smsu.edu/sbk00.htm (Online book)
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 (Chance magazine)
8. www.statsci.org/datasets.html (Data sets)
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

Paper III - Practical

Pre-requisites: Knowledge of the topics in theory papers I and II.
Objectives: At the end of this course students are expected to be able
  (i)   to use various graphical and diagrammatic techniques and interpret.
  (ii) to compute various measures of central tendency, dispersion, skewness and kurtosis,
  (iii) to compute correlation coefficient, regression coefficients,
  (iv) to fit binomial and Poisson distributions,
  (v)   to analyse data pertaining to discrete and continuous variables and to interpret the results,
  (vi) to compute probabilities of bivariate distributions,

(vii) to interpret summary statistics of computer output.

(viii) to summarize and analyze the data using computer.

(ix) to draw random samples from Poisson and binomial distributions.

No.	Title of the Experiment
1	Diagrammatic representation of statistical data: simple and subdivided bar diagrams, multiple bar diagram, percentage bar diagram, pie diagram
2	Graphical representation of statistical data: histogram, frequency curve and ogive curves. Determination of mode and median graphically
3	Use of random number tables to draw SRSWOR, SRSWR, stratified sample and systematic sample
4	Computation of measures of central tendency and dispersion (ungrouped data). Use of an appropriate measure and interpretation of results and computation of partition values
5	Computation of measures of central tendency and dispersion (grouped data). Use of an appropriate measure and interpretation of results and computation of partition values
6	Measures of skewness and kurtosis, Box plot
7	Scatter diagram, correlation coefficient (ungrouped data) Fitting of line of regression, residual plot
8	Fitting of second degree curve, exponential curve of type $y = ab^x$, $y = ax^b$ comparison, finding the best fit using mean residual s.s. and coefficient of determination
9	Fitting of binomial distribution and computation of expected frequencies
10	Fitting of Poisson distribution and computation of expected frequencies
11	Problems on Bivariate Probability distributions
12	Applications of binomial and hypergeometric distributions
13	Applications of Poisson and geometric distributions
14	Model sampling from Poisson and binomial distributions
15	Index numbers
16	Graphical and diagrammatic representation of statistical data using Excel
17	Use of random numbers to draw SRSWOR, SRSWR, Stratified sample and systematic sample using MS Excel
18	Computation of summary statistics using MS Excel
19	Scatter diagram, correlation coefficient, fitting a line of regression, fitting of second degree curve, using MS Excel
20	Project equivalent to 5 practicals

Notes:
1. For project, a group of maximum 8 students be made
2. All the students in a group be given equal marks for project.
3. Different data sets from newspapers, internet, magazines may be collected and students will be asked to use Statistical techniques/tools which they have learnt.

4. Students must complete all the practicals to the satisfaction of the teacher concerned.
5. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

11) Qualification of Teachers: As per the University and UGC regulations.