National Curriculum for

STATISTICS

GRADES XI-XII

2009

GOVERNMENT OF PAKISTAN
MINISTRY OF EDUCATION
ISLAMABAD

TABLE OF CONTENTS

INTRODUCTION

Statistical thinking will one day be as necessary
as the ability to read and write
H.G. Wells (1886-1946)

Importance of Statistics

An information- and technology-based society requires individuals, who are able to think critically about complex issues, analyze and adapt to new situation, solve problems of various kinds and communicate their thinking effectively. The study of statistics equips students with knowledge, skills, powerful intellectual tools and habits of mind that are essential for successful and rewarding participation in such a society.

Statistics is about data, information presented numerically, and about using that information in ways that inform the user, providing a knowledge base for making decisions and for facing uncertainties. According to Cobb and Moore (1997), statistics is a methodological discipline. It exists not for itself, but rather to offer to other fields of study a coherent set of ideas and tools for dealing with data. In GAISE report Franklin et al (2005) argue that a major objective of statistics education is to help students develop statistical thinking. The statistical thinking, in large part, must deal with the omnipresence of variability.

Statistics and Academia

The world renowned education systems are responding to the increasingly important role of statistics by including statistical strands in their curricula particularly in mathematics. The fourth standard of National Curriculum for Mathematics (2006), the competency of which reads as 'Information Handling', does cater for the similar expectations.

The curriculum issues in statistics education have long been under discussion of the academia at different international forums. Articles regarding statistics education can be found in the Statistics Education Research Journal (SER) and the Journal of Statistics Education (JSE) both published by International Association for Statistical Education (IASE) and American Statistics Association (ASA) respectively.

The IASE Roundtable on Curriculum Development in Statistics Education, held in Sweden in 2004, provided a platform to twenty six participants from nine countries to discuss main issues of the statistics curriculum from primary school to tertiary level. Burrill (2005) discusses the curriculum issues in statistics education and suggests that:

- More opportunities need to be created for students to question critically the statistical claims from real-world contexts

- Frequent situations, appropriate to statistical understanding are required to be developed so that students may become critical consumers of statistics
- Attention need to be paid that students learn the importance of careful designs for collecting data

Through its articles the Sixty-eighth Yearbook (NCTM 2006) makes the vision come alive that is highlighted in the Principles and Standards (NCTM 2000) and is stated as – the students should be able to:

- Formulate questions that can be addressed with data and collect, organize and display relevant data to answer them
- Select and use appropriate statistical methods to analyze data
- Develop and evaluate inferences and predictions based on data
- Understand and apply basic concepts of probability

The Curriculum of Statistics

The main objective to review the national curriculum is to make it more vibrant and more responsive to the modern, socio-economic, technical, professional, and labour market needs of the country. It should be improved and uplifted to make it comparable with international standards.

The National Curriculum of Statistics has been designed in the light of above recommendations coupled with the suggestions of our stakeholders. The following themes permeate the curriculum:

- The learning-outcomes oriented National Curriculum of Statistics extends the scope of rudiments of statistics falling under the fourth standard (Information Handling) of National Curriculum for Mathematics (2006)
- It helps students to build the solid conceptual foundation in statistics that will enable them to apply their knowledge skillfully
- It stresses on visual communication – representing data, interpreting and depicting situations
- The curriculum is not merely centered on the theoretical underpinnings of the subject but emphasizes on real-life problems which enable the students to linkup their thinking to the real-world contexts

CURRICULUM OF STATISTICS FOR GRADE – XI

UNIT 1 COLLECTION AND PRESENTATION OF DATA

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
1.1 Introduction	i) Define statistics. ii) Differentiate between: • Population and sample • Parameter and statistics iii) Distinguish between descriptive and inferential statistics, theoretical statistics and applied statistics. iv) Define: • Statistical inquiry (survey) • Statistical observations
1.2 Variable	i) Define: • A constant • A variable, its domain and its observed values ii) Describe: • The types of a variable; qualitative and quantitative • The types of quantitative variable; discrete and continuous
1.3 Measurement Scales	i) Recognize the measurement scales: • Nominal scale • Ordinal (or ranking) scale • Interval scale • Ratio scale ii) Apply an appropriate measurement scale when collecting the statistical observations (data), iii) Define an error of measurement, iv) Explain the rules to round-off the numbers, v) Apply the rules for rounding-off the numbers to desired accuracy.
1.4 Statistical Data	i) Define and identify the types of statistical data: • Qualitative and quantitative data • Discrete and continuous data

	• Chronological (time series) and geographical (spatial) data • Primary and secondary data ii) Describe the characteristics of statistical data. iii) Explain how primary data are collected through: • Direct personal investigation • Indirect investigation • Questionnaires to be filled in by the informants /enumerators • Registration by local correspondents • Designed experiments iv) Signify the sources of secondary data: • Official and semi-official sources • Research organizations • Journals, newspapers and internet/electronic media
1.5. Presentation of Statistical Data.	i) Condense the collected statistical data: • Using the data array • Through classification and tabulation, • By diagrammatic/graphic representation ii) Identify the merits and demerits of data arrays. iii) Arrange a data array from the given individual observations (raw data) and symbolize the observations and the data array. iv) Define tabulation and describe its main steps. v) Specify the main parts of the table. vi) Define: • Classification • Class • Class frequency vii) Classify the qualitative observations (up to two attributes). viii) Define frequency distribution. ix) Differentiate between discrete and grouped frequency distributions. x) Construct a discrete frequency distribution from the given discrete observations and represent it symbolically. xi) Define: (for continuous variables)

	• Class limits • Class boundaries • Class width or interval • Class mark or midpoint xii) Describe the steps involved in the construction of a grouped frequency distribution. xiii) Construct a grouped frequency distribution from the given continuous observations and represent it symbolically. xiv) Define and construct: • The cumulative frequency distribution • The relative frequency distribution • The cumulative relative frequency distribution • The percentage frequency distribution • The cumulative percentage frequency distribution for continuous variables xv) Describe diagrammatic/graphic representation of data and identify its merits and demerits. xvi) State the types of charts/diagrams. xvii) Define and construct: • Simple bar chart • Multiple bar chart • Subdivided / component bar chart • Percentage subdivided rectangles • Pie/sector chart for a qualitative data. xviii) Define and construct: • Simple bar chart/histogram • Cumulative frequency polygon for a discrete frequency distribution. xix) Define and construct: • Histogram • Frequency polygon • Frequency curve • Cumulative frequency polygon (ogive) • Cumulative frequency curve for a grouped frequency distribution.

1.6.	Type of Frequency Curves or Distributions.	Recognize the types of frequency curves/distributions: • Uniform distribution • Symmetrical distribution • Positively skewed distribution • Negatively skewed distribution • Moderately skewed distribution • Extremely skewed distribution • U-shaped distribution • Bi-modal distribution
1.7.	Summation and Product Notations.	i) Recognize summation/sigma notation '$\sum$' to indicate the sum of a sequence of observations. ii) Expand a sum given in '$\sum$' notation into an explicit sum. iii) Write an explicit sum in '$\sum$' notation where there is an obvious pattern to the individual terms. iv) Use the following rules to manipulate sums expressed in $\sum$' notation: • $\sum_{i=1}^{n}(x_i + y_i) = \sum_{i=1}^{n} x_i + \sum_{i=1}^{n} y_i$ • $\sum_{i=1}^{n} cx_i = c\sum_{i=1}^{n} x_i$, where c is a constant • $\sum_{i=1}^{n} c = nc$, where c is a constant v) Describe the meanings of double-summation notation $\sum_{i=1}^{n}\sum_{j=1}^{m}$ vi) Use the following rules to manipulate double-summation notation: • $\sum_{i=1}^{n}\sum_{j=1}^{m}(x_{ij} + y_{ij}) = \sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij} + \sum_{i=1}^{n}\sum_{j=1}^{m} y_{ij}$ • $\sum_{i=1}^{n}\sum_{j=1}^{m} cx_{ij} = c\sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij}$, where c is a constant • $\sum_{i=1}^{n}\sum_{j=1}^{m} c = nmc$, where c is a constant

	• $\sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij} = \sum_{j=1}^{m}\sum_{i=1}^{n} x_{ij}$ • $\sum_{i=1}^{n}\sum_{j=1}^{m} x_i y_j = \left[\sum_{i=1}^{n} x_i\right]\left[\sum_{j=1}^{m} y_j\right]$ vii) Recognize product/pie notation '$\prod$' to indicate the product of a sequence of observations. viii) Expand a product given in '$\prod$' notation, into an explicit multiplication from. ix) Write an explicit multiplication form in '$\prod$' notation where there is an obvious pattern to the individual terms. x) Use the following rules to manipulate products expressed in '$\prod$' notation: • $\prod_{i=1}^{n} cx_i = c^n \prod_{i=1}^{n} x_i$ where c is a constant • $\prod_{i=1}^{n} c = c^n$ where c is a constant • $\log\left(\prod_{i=1}^{n} x_i\right) = \sum_{i=1}^{n} (\log x_i)$ • $\prod_{i=1}^{n} (x_i y_i) = \left[\prod_{i=1}^{n} x_i\right]\left[\prod_{i=1}^{n} y_i\right]$ • $\prod_{i=1}^{n}\left(\frac{x_i}{y_i}\right) = \frac{\prod_{i=1}^{n} x_i}{\prod_{i=1}^{n} y_i}$

UNIT 2: MEASURES OF CENTRAL TENDENCY

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
2.1 Central Tendency.	i) Define central tendency. ii) Know, what the measure of central tendency is. iii) Define an average and list its types (arithmetic mean, median, mode, geometric mean, harmonic mean and mid-range). iv) State the properties of an idea/good average.
2.2 Arithmetic Mean.	i) Define arithmetic mean and weighted arithmetic mean. ii) Recognize the properties of arithmetic mean. iii) Identify the merits and demerits of arithmetic mean. iv) Calculate arithmetic mean for individual observations (raw data): • By definition • Using deviations from an assumed mean v) Calculate arithmetic mean for a frequency distribution: • By definition • By coding and scaling vi) Find arithmetic mean directly using the calculator in statistical (STAT/SD) mode. vii) Solve real life problems involving arithmetic mean.
2.3 Median.	i) Define median, quartiles, deciles and percentiles. ii) Recognize the properties of median. iii) Identify the merits and demerits of median. iv) Determine: • Median and quartiles for individual observations (raw data) • Median, quartiles, deciles and percentiles for a discrete frequency distribution • Median, quartiles, deciles and percentiles for a grouped frequency distribution v) Estimate the median and quartiles through graph. vi) Solve real life problems involving median, quartiles, deciles and percentiles.

2.4 Mode.	i) Define mode. ii) Recognize the properties of mode. iii) Identify the merits and demerits of mode. iv) Determine mode for: • Individual observations (raw data) • A discrete frequency distribution • A grouped frequency distribution v) Estimate the mode through graph for continuous and discrete distribution. vi) Discuss the empirical relationship between arithmetic mean, median and mode. vii) Solve real life problems involving mode.
2.5 Geometric Mean.	i) Define geometric mean and weighted geometric mean. ii) Recognize the properties of geometric mean. iii) Identify the merits and demerits of geometric mean. iv) Calculate geometric mean for individual observations (raw data): • By definition • Using logarithms v) Calculate geometric mean for a frequency distribution. vi) Solve real life problems involving geometric mean.
2.6 Harmonic Mean.	i) Define harmonic mean and weighted harmonic mean. ii) Recognize the properties of harmonic mean. iii) Identify the merits and demerits of harmonic mean. iv) Calculate harmonic mean for: • Individual observations (raw data) • A frequency distribution iv) Verify the relations between arithmetic mean, geometric mean and harmonic mean. v) Solve real life problems involving harmonic mean.

UNIT 3: MEASURES OF DISPERSION, SKEWNESS AND KURTOSIS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
3.1. Dispersion.	i) Define dispersion. ii) Know, what the measure of dispersion is. iii) State the properties of an idea/good measure of dispersion. iv) Identify the types of measure of dispersion- absolute and relative. v) Know the types of absolute and relative measures of dispersion: • Range and coefficient of range • Quartile deviation and coefficient of quartile deviation • Mean deviation and coefficient of mean deviation • Standard deviation and coefficient of variation
3.2. Range.	i) Define range, semi-range and coefficient of range. ii) Recognize the properties of range. iii) Identify the merits and demerits of range. iv) Determine the range, semi-range and coefficient of range for: • Individual observations (raw data) • A discrete frequency distribution • A grouped frequency distribution v) Solve real life problems involving range.
3.3 Quartile Deviation.	i) Define inter-quartile range, mid-quartile range, quartile deviation (or semi-inter-quartile range) and coefficient of quartile deviation. ii) Recognize the properties of quartile deviation. iii) Identify the merits and demerits of quartile deviation. iv) Determine the inter-quartile range, mid-quartile range, quartile deviation and coefficient of quartile deviation for: • Individual observations (raw data) • A discrete frequency distribution • A grouped frequency distribution v) Solve real life problems involving quartile deviation.
3.4 Mean Deviation.	i) Define mean deviation and coefficient of mean deviation: • From mean • From median • From mode ii) Recognize the properties of mean deviation.

	iii) Identify the merits and demerits of mean deviation. iv) Calculate mean deviation and coefficient of mean deviation for individual observations (a frequency distribution): • From mean • From median • From mode v) Solve real life problems involving mean deviation.
3.5 Standard Deviation.	i) Define variance, standard deviation and coefficient of variation. ii) Define mean square deviation. iii) Recognize the properties of variance and standard deviation. iv) Identify the merits and demerits of standard deviation. v) Describe the uses of standard deviation and coefficient of variation. vi) Calculate variance, standard deviation and coefficient of variation for individual observations (raw data): • By definition • Using the deviations from an assumed mean vii) Calculate variance, standard deviation and coefficient of variation for a frequency distribution: • By definition • Using the deviations from an assumed mean (coding and scaling) viii) Calculate variance using the formula: variance = (mean of the squares) – (square of the mean). ix) Recognize the error of grouping. x) Describe and apply the Sheppard's correction to variance for a grouped frequency distribution. xi) Find the standard deviation directly using the calculator in statistical (STAT/SD) mode. xii) Solve real life problems involving variance and standard deviation.
3.6 Moments.	i) Define moments: • About arithmetic mean • About any arbitrary point • About the origin ii) Calculate moments about arithmetic mean, about any

	arbitrary point and about the origin: • For individual observations (raw data) • For a frequency distribution iii) Describe and apply: • The relationship expressing moments about mean in terms of moments about any arbitrary point • The relationship expressing moments about mean in terms of moments about the origin iv) Describe and apply the Sheppard's corrections to moments for a grouped frequency distribution. v) Define moment ratios. vi) Calculate moment ratios.
3.7 Skewness.	i) Define symmetrical distribution. ii) Recognize the following properties of a symmetrical distribution. • Mean = median = mode • Third quartile = median = median = first quartile • All odd ordered moments about mean vanish • First moment ratio = 0 iii) Define: • Skewness • Skewed distribution (positively or negatively) • Coefficient of skewness iv) Determine the coefficient of skewness using: • Lyon Bowley's formula • Karl Pearson's formulae (involving mode and median only) v) Interpret the coefficient of skewness. vi) Solve real life problems involving coefficient of skewness.
3.8 Kurtosis.	i) Define kurtosis. ii) Identify a given symmetrical distribution as platykurtic, mesokurtic or leptokurtic. iii) Solve real life problems involving kurtosis.

UNIT 4: INDEX NUMBERS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
4.1 Index Numbers.	i) Define index numbers. ii) Describe the steps involved in the construction of wholesale price index numbers: • Purpose and scope • Selection of commodities to be included • Collection of prices • Selection of base period (fixed base method, chain base method and chain indices) • Choice of average (arithmetic mean, median or geometric mean) to be used • Selection of appropriate weights iii) Define simple and composite price index numbers. iv) Calculate simple price index numbers: • By fixed base method • By chain base method v) Describe the method of simple aggregates. vi) Calculate composite price index numbers using the method of simple aggregates. vii) Identify the merits and demerits of the method of simple aggregates viii) Describe the method of simple average of relatives. ix) Calculate composite price index numbers using the method of simple average of relatives. x) Identify the merits and demerits of the method of simple average of relatives. xi) Describe the method of weighted aggregates. xii) Calculate weighted aggregative composite price index numbers. xiii) Identify the merits and demerits of the method of weighted aggregates. xiv) Calculate weighted aggregative composite price index numbers using: • Laspeyer's formula

		• Paache's formula • Fisher's formula xv) Describe the method of weighted average of relatives. xvi) Calculate weighted average of relative composite price index numbers. xvii) Identify the merits and demerits of the method of weighted average of relatives. xviii) Calculate weighted average of relatives composite price index numbers using: • Laspeyer's formula • Paache's formula
4.2	Consumer Price Index Numbers.	i) Define the consumer price index (CPI) numbers. ii) Discuss the steps involved in the construction of consumer price index numbers: • Scope • Household budget inquiry • Allocation of weights • Collection of consumer prices iii) Calculate consumer price index numbers using: • Aggregate expenditure method • Household budget method
4.3	Interpretation of Index Numbers.	i) Describe: • The uses of index numbers • Limitations of index numbers ii) Interpret the computed index numbers.

UNIT 5: SIMPLE LINEAR REGRESSION AND CORRELATION

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
5.1 Simple Linear Regression.	i) Define: • Independent and dependent variables • Simple regression ii) Describe regression function and regression curve. iii) Define scatter diagram and discuss its role. iv) Define simple linear regression and identify its regression coefficient. v) Describe the least squares principle. vi) Use the method of least squares to fit a regression line (including coding and scaling). vii) Interpret the regression coefficient. viii) Recognize the properties of a least squares regression line. ix) Fit a regression line directly using the calculator in LR (linear regression) mode. x) Use least squares approach to solve appropriate real life problems.
5.2 Simple Linear Correlation.	i) Define covariance between two variables. ii) Define simple linear correlation between two random variables. iii) Describe: • Positive correlation and perfect positive correlation • Negative correlation and perfect negative correlation • No correlation iv) Differentiate between simple linear correlation and regression. v) Define simple linear correlation coefficient (also called Pearson product-moment correlation coefficient). vi) Calculate Pearson product-moment correlation coefficient between two variables using: • The deviations from their respective means • The deviations from respective assumed means • The original respective observations

	vii) Use the method of least squares to fit two regression lines (including coding and scaling). viii) Determine the correlation coefficient from two given regression coefficients. ix) Interpret the simple linear correlation coefficient. x) Recognize the properties of simple linear correlation coefficient. xi) Find simple linear correlation coefficient directly using the calculator in LR (linear regression) mode. xii) Use the simple linear correlation coefficient to solve appropriate real life problems.
5.3 Rank Correlation.	i) Define: • Rank correlation • Coefficient of rank correlation ii) Find the coefficient of rank correlation to measure the association between two qualitative variables.

UNIT 6: TIME SERIES

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
6.1 Time Series.	i) Define time series. ii) Define and construct historiogram. iii) Describe the components of a time series: • Secular trend • Seasonal variations • Cyclical fluctuations • Irregular movements iv) Explain 'analysis of time series'. v) Describe additive and multiplicative models utilized for analysis of time series. vi) Explain the technique of coding the time variable.
6.2 Measurement of Secular Trend.	i) Describe and apply the method of freehand curve to measure the secular trend. ii) Identify the merits and demerits of the freehand curve method. iii) Describe and apply the method of semi-averages to measure the secular trend including the algebraic form of semi-averages trend line. iv) Identify the merits and demerits of the method of semi-averages. v) Describe and apply the method of moving averages to measure the secular trend. vi) Identify the merits and demerits of the method of moving averages. vii) Describe and apply the method of least squares to measure: • Linear secular trend • Quadratic secular trend for estimating trend values. viii) Describe and apply the technique of shifting of origin in the least squares secular trend. ix) Identify the merits and demerits of the least squares secular trend.

UNIT 7: VITAL STATISTICS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
7.1 Introduction.	i) Define: • Vital events • Vital statistics ii) Know the sources of data: • Vital registration system • Population census • Sample survey iii) Discuss the uses and shortcomings of vital statistics.
7.2 Vital Ratios.	i) Differentiate between rates and ratios. ii) Define: • Gender-sex ratio • Child-women ratio • Vital index (birth-death ratio)
7.3 Mortality Rates.	i) Define: • Mortality • Crude death rate • Specific death rates – age-specific, sex-specific and age-sex-specific • Infant mortality rate • Neo-natal mortality rate • Still-birth rate • Maternal death rate ii) Find crude death rate and specific death rates (age-specific, sex-specific and age-sex-specific) from a given data. iii) Define the standardized death rate. iv) Describe direct and indirect methods to find the standardized death rate from a given data. v) Calculate the standardized death rate from a given data using direct and indirect methods.

7.4	Measurement of Fertility.	i) Define: • Fertility • Crude birth rate • Crude rate of natural increase • Population growth rate • Age-specific birth rate ii) Define the standardized birth rate. iii) Describe the standardized birth rate using direct and indirect methods. iv) Define: • General fertility rate • Age-specific fertility rate • Total fertility rate v) Calculate general fertility rate, age-specific fertility rate and total fertility rate from a given data.
7.5	Reproduction Rate.	i) Define: • Gross reproduction rate • Net reproduction rate ii) Find gross and net reproduction rates from a given data.

UNIT 8: INTERPOLATION

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
8.1 Interpolation.	i) Identify arguments and entries in a given table of values $(x_i, y_i), i = 0,1,2,.....,n$ ii) Differentiate between equally-spaced and un-equally spaced data. iii) Define: • Interpolation • Interpolating polynomial iv) Define ' Δ ' as the forward difference operator. v) Define $\Delta y, \Delta^2 y, \Delta^3 y, ..., \Delta^n y$, as 1st, 2nd, 3rd, ..,nth differences from the table of values $(x_i, y_i), i = 0,1,2,...,n$ vi) Construct forward difference table from a given equally-spaced data.
8.2 Newton's Forward Difference Interpolation Formula.	i) Describe Newton's forward difference interpolation formula. ii) Use Newton's forward difference interpolation formula to find interpolating polynomial for a given equally-spaced data. iii) Use Newton's forward difference formula to interpolate the value of y at a given x.
8.3 Lagrange's Interpolation Formula.	i) Describe Lagrange's interpolation formula. ii) Use Lagrange's interpolation formula to find interpolating polynomial for a given equally- or unequally-spaced data. iii) Use Lagrange's interpolating formula to interpolate the value of y at a given value of x.

UNIT 9: LINEAR PROGRAMMING.

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
9.1 Linear Inequalities.	i) Recall origin (O) and coordinate axes (x-axis and y-axis) in Cartesian plane. ii) Differentiate between linear equation and linear inequality. iii) Recognize: • Upper-and lower-half planes • Left-and right-half planes iv) Solve a linear inequality in one variable and depict it on the number line. v) Draw the graph of a linear inequality in two variables. vi) Identify graphically the common region bounded by a system of (up to 3) linear inequalities of two non-negative variables.
9.2 Linear Programming.	i) Define: • Linear programming (LP) problem • Objective function • Problem constraints • Decision variables • Corner points • Feasible region ii) Show graphically the feasible region (or solution space) of an LP problem. iii) Identify the feasible region of a simple LP problem. iv) Find maximum and minimum values of objective function in a simple LP problem.
9.3 Optimal Solution.	i) Explain the term optimal solution of an LP problem. ii) Find optimal solution, graphically, through the following systematic procedure, that is: • Establish the mathematical formulation of LP problem

	• Construct the graph • Identify the feasible region • Locate the solution (corner) points • Evaluate the objective function at solution points • Select the optimal solution • Verify the optimal solution by actually substituting values of variables from the feasible region iii) Apply LP graphical technique to solve appropriate real life problems,

CURRICULUM OF STATISTICS FOR GRADE-XII

UNIT 1: PROBABILITY

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
1.1 Counting Techniques.	i) Know, n! (n factorial) as the notation to express the product of first n natural numbers. ii) Describe fundamental principle of counting and illustrate it using tree diagram. iii) Explain the meaning of permutation. iv) Interpret ${}^{n}P_{r}$ as the number of permutations of n different objects taken r at a time which is expressed by the formula: ${}^{n}P_{r} = n(n-1)(n-2)...(n-r+1)$ v) Deduce that: • ${}^{n}P_{r} = \frac{n!}{(n-r)!}$ • ${}^{n}P_{r} = n!$ • $0! = 1$ vi) Explain the meaning of combination. vii) Interpret 'C', as the number of combinations of n different objects taken r at a time which is expressed by the formula: ${}^{n}C_{r} = \binom{n}{r} = \frac{n!}{r!(n-r)!}$ viii) Deduce that: • $\binom{n}{n} = \binom{n}{0} = 1$ • $\binom{n}{r} = \binom{n}{n-r}$ • $\binom{n}{1} = \binom{n}{n-1} = n$ • $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$

1.2	Introduction to Probability.	i) Define the following: • Random experiment (with real life examples) • Sample space, sample point and random event • Simple and compound events • Impossible and sure events • Complimentary events • Equally likely events • Exhaustive events • Mutually exclusive events ii) Elaborate the term 'probability' through: • Its classical definition • Its relative frequency definition • Its axiomatic definition iii) Recognize the formula for probability of occurrence of an event A, that is, $P(A) = \frac{n(A)}{n(S)}, 0 \le P(A) \le 1$ iv) Apply the formula for finding probability in simple cases. v) Use Venn diagrams to find the probability for the occurrence of an event.
1.3	Laws of Probability.	i) Describe: • Probability of non-occurrence of an event • Odds for the occurrence of an event • Odds against the occurrence for an event ii) Recognize the law of probability of complementation. iii) State the laws of probability under addition. iv) Apply the laws of probability under addition to solve real life problems. v) Differentiate between dependent and independent events. vi) Define the conditional probability. vii) State the laws of probability under multiplication. viii) Apply the laws of probability under multiplication to solve real life problems. ix) Compute probabilities for real life problems involving: • Counting techniques • Infinite geometric progression • Probability trees

UNIT 2 RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
2.1 Random Variable	i) Define random variable. ii) Differentiate between discrete and continuous random variables with real life examples.
2.2 Discrete Random Variable	i) Describe the probability distribution of a discrete random variable. ii) Find the probability distribution of a discrete random variable. iii) Recognize probability mass function. iv) Describe the probability distribution of a function of discrete random variable. v) Find the probability distribution of a function of discrete random variable. vi) Define the expected value of a discrete random variable. vii) Find the expected value of a discrete random variable. viii) Define the expected value of a linear function of a discrete random variable. ix) Find the expected value of a linear function of a discrete random variable. x) Describe and verify the properties of expected value of a discrete random variable. xi) Apply the properties of expected value of a discrete random variable. xii) Define variance and standard deviation of a discrete random variable. xiii) Find variance and standard deviation of a discrete random variable. xiv) Define variance and standard deviation of a linear function of a discrete random variable. xv) Find variance and standard deviation of a linear function of a discrete random variable. xvi) Describe and verify the properties of variance and standard deviation of a discrete random variable. xvii) Apply the properties of variance and standard deviation of a discrete random variable.

2.3	Continuous Random Variable	i) Define: • Probability distribution of a continuous random variable • Probability density function ii) Define expected value, variance and standard deviation of a continuous random variable. iii) Find expected value, variance and standard deviation of a continuous random variable.
2.4	Two Independent Random Variables	i) Describe the following properties about the expected value and variance for the sum/difference of two independent random variable X and Y: • $E(X \pm Y) = E(X) \pm E(Y)$ • $E(aX \pm bY) = aE(X) \pm bE(Y)$ • $Var(X \pm Y) = Var(X) \pm Var(Y)$ • $Var(aX \pm bY) = aVar(X) \pm bVar(Y)$ ii) Apply the above properties.

UNIT 3 SPECIAL DISCRETE PROBABILITY DISTRIBUTIONS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
3.1 Discrete Uniform Distribution	i) Define the following: • A discrete uniform random variable • A discrete uniform probability distribution • A discrete uniform probability mass function ii) Calculate mean, variance and standard deviation of a discrete uniform probability distribution. iii) Define random digits/numbers. iv) Know, how the random digits/numbers are generated. v) Solve real life problems using discrete uniform probability distribution.
3.2 Bernoulli Distribution	i) Define the following: • The Bernoulli trials • A Bernoulli random variable • A Bernoulli probability distribution • A Bernoulli probability mass function ii) Calculate mean, variance and standard deviation of a Bernoulli probability distribution. iii) Solve real life problems using Bernoulli probability distribution.
3.3 Binomial Distribution	i) Define the following: • A binomial experiment • A binomial random variable • A binomial probability distribution • A binomial probability mass function • A binomial frequency distribution ii) Calculate mean, variance and standard deviation of a binomial probability distribution. iii) Solve real life problems using binomial probability distribution.
3.4 Hyper geometric Distribution	i) Define the following: • A hyper geometric experiment • A hyper geometric random variable • A hyper geometric probability mass distribution • A hyper geometric probability mass function ii) Calculate mean, variance and standard deviation of a hyper geometric probability distribution. iii) Solve real life problems using hyper geometric probability distribution.

UNIT 4 SPECIAL CONTINUOUS PROBABILITY DISTRIBUTIONS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
4.1 Continuous Uniform Distribution	i) Define the following: • A continuous uniform probability distribution • A continuous uniform probability density function ii) Find mean, variance and standard deviation of a continuous uniform probability distribution iii) Solve real life problems using continuous uniform probability distribution.
4.2 Normal Distribution	i) Define the following: • A normal probability distribution • A normal probability density function • A normal cumulative distribution function • A standard normal random variable • A standard normal distribution • A standard normal probability density function • A standard normal cumulative distribution function ii) Describe the properties of a normal probability distribution. iii) Find the ordinates of the standard normal curve using the table of the ordinates of the standard normal curve. iv) Find the probabilities for the standard normal random variable using the table of the standard normal distribution function. v) Find the ordinates of a normal curve using the table of the ordinates of the standard normal curve. vi) Find the probabilities for a normal random variable using the table of the standard normal distribution function. vii) Use the table of quantiles of standard normal curve/distribution(inverse standard normal cumulative distribution function) to determine the value of:

	• Standard normal random variable corresponding to a given value of the standard normal cumulative distribution function • A normal random variable corresponding to a given value of a normal cumulative distribution function • Parameter(s) of a normal random variable viii) Describe the normal distribution as a limit of frequency distribution. ix) Solve real life problems using normal probability distribution.

UNIT 5 SAMPLING AND SAMPLING DISTRIBUTIONS

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
5.1 Survey Sampling	i) Define: • Sampling • Sampling units • Sampling frame • Sampling design ii) Differentiate between: • Finite and infinite populations • Sample survey and complete enumeration iii) Describe advantages and limitations of sampling. iv) Distinguish between: • Non-probability/non-random sampling and probability / random sampling • Random sampling with and without replacement v) Differentiate between sampling and non sampling errors. vi) Describe the sampling techniques: • Simple random sampling • Stratified random sampling • Systematic random sampling vii) Use the random digit/number table to select a simple random sample from a given finite population.
5.2 Sampling Distribution of Sample Mean	i) Define: • Sampling distribution of statistics • Standard error of statistics ii) Define a sampling distribution of sample mean. iii) Describe the properties of a sampling distribution of sample mean. iv) Construct the sampling distribution of sample mean to verify its properties about its mean and variance.
5.3 Sampling Distribution of Difference between two Sample Means	i) Define a sample distribution of difference between two sample means. ii) Describe the properties of sampling distribution of difference between two sample means. iii) Construct the sample distribution of difference between

			two sample means to verify its properties about its mean and variance.
5.4	Sampling Distribution of Sample Proportion	i) ii) iii)	Define sampling distribution of a sample proportion. Describe the properties of a sampling distribution of sample proportion. Construct the sampling distribution of sample proportion to verify its properties about its mean and variance.
5.5	Sampling Distribution of Difference between Two Sample Proportions	i) ii) iii)	Define sampling distribution of difference between two sample proportions. Describe the properties of sampling distribution of difference between two sample proportions. Construct sampling distribution of difference between two sample proportions to verify its properties about its mean and variance.

UNIT 6 ESTIMATION

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
6.1 Introduction	i) Define: • Estimation of a parameter • Point estimation of a parameter: - Point estimator - Point estimate ii) Differentiate between point estimator and point estimate. iii) Describe, from a random sample, the point estimators and point estimates for population mean (population variance) and hence find their point estimates from the given random sample.
6.2 Point Estimation	i) Define: • Unbiasedness • Unbiased estimator • Biased estimator • Bias ii) Describe the methods to reduce bias in sample surveys. iii) Describe and verify the unbiasedness of: • Sample mean • Sample proportion • Sample variance iv) Use calculator in statistical (STAT/SD) mode to find directly the unbiased estimates of mean and variance of the population from which the sample was drawn. v) Define efficiency vi) Explain best estimator vii) Identify the best estimator of: • Population mean • Population variance • Population proportion viii) Find the best estimates of population mean and population variance from a given random sample. ix) Find the best estimate of population proportion from a given random sample.

	x) Identify the pooled estimators, from two samples, of: • Population mean • Population variance • Population proportion xi) Find the pooled estimates of population mean and population variance from two given random samples. xii) Find the pooled estimate of population proportion from two given random samples.
6.3 Interval Estimation	i) Define: • Interval estimation of a parameter; - Confidence coefficient - Interval estimate ii) Explain and estimate the confidence interval for: • The mean of a normal population (known and unknown standard deviation) • The difference between means of two normal populations (known and unknown standard deviations) • The population proportion (large sample) • The difference between proportions of two populations (large samples).

UNIT 7 HYPOTHESIS TESTING

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
7.1 Introduction	i) Describe statistical hypothesis and hypothesis testing. ii) Differentiate between: • Null and alternative hypotheses • Simple and composite hypotheses iii) Formulate null and alternative hypotheses. iv) Recognize the elements involved in hypothesis testing: • Test statistic • Rejection and non-rejection regions • Critical value(s) • One-tailed (left-or right-tailed) test • Two-tailed test • Type-I and Type-II errors • Level of significance • Decision rule • Conclusion
7.2 Hypothesis Testing	Apply the test of hypothesis about: • The mean of a normal population (known/ unknown standard deviation) • The population proportion (large sample) • The difference between means of two normal populations (known/unknown standard deviations) • The difference between proportions of two populations (large samples)

UNIT 8 ASSOCIATION OF ATTRIBUTES

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
8.1 Attribute	i) Recall variable and attribute. ii) Recognize the notations and terminology to represent the presence and absence of attribute. iii) Describe class and class frequency. iv) Recognize the categorical data of two attributes. v) Explain independence of two attributes. vi) Know the criterion of independence of two attributes. vii) Discuss the association of two attributes: • Positive association • Negative association • Complete association • Complete disassociation viii) Define the coefficient of association. ix) Find the coefficient of association and given its interpretation.
8.2 Contingency Table	i) Define a contingency table. ii) Know the criterion of independence of two attributes in a contingency table. iii) Test whether two attributes, in a given contingency table, are statistically independent or not. iv) Describe Pearson's coefficient of mean square contingencies v) Calculate Pearson's coefficient of mean square contingency for a given contingency table and find its maximum value. vi) Describe and apply Yate's correction for continuity to test the statistical independence of two given attributes.

UNIT 9 DESIGN OF EXPERIMENT

Contents and Scope	Learning Outcomes/Skills
	The students will be able to:
9.1 Introduction	i) Describe the meanings of the design of experiment. ii) Explain the elements involved in designing an experiment: • The experimental unit • The treatment • The replication • The response • The layout of the experiment
9.2 Completely Randomized Design	i) Define: • Randomization • Completely randomized design ii) Give layout plan of completely randomized design. iii) Identify the merits and demerits of completely randomized design.
9.3 Analysis of Variance	i) Know the meanings of analysis of variance. ii) State the assumptions of analysis of variance. iii) Describe and calculate: • The total sum of squares • The treatment sum of squares • The error sum of squares iv) Describe and calculate the degrees of freedom for: • The total sum of squares • The treatment sum of squares • The error sum of squares v) Describe and calculate: • The treatment mean square • The error mean square vi) Test the equality of means of several normal populations.

TEACHING STRATEGIES

Introduction

The interest towards beliefs, attitudes and expectations that students bring into statistics classroom has been increasing in statistics education. In the technology-based society, teaching is being recognized as a complex and multifaceted product of several variables and the culture of teaching and learning is changing. Very often teaching and learning at college / university seems to be focused on students' passing the prescribed assessments (examinations) and gaining the paper credentials for the required certificate/degree. Students seem to be mastering statistical procedures and vocabulary but are not able to use statistical reasoning in a meaningful way. In such an environment, obviously, long-term objectives of teaching or learning cannot be attained.

To capture all aspects of expertise, competence, knowledge and facility which are necessary to learn and mathematical science like statistics the following interwoven but interdependent strands, presented by Kilpatrick et al (2001) to attain mathematical proficiency, may be incorporated.

- **Conceptual understanding –** comprehension of the concepts, operations and relations
- **Procedural fluency –** skill in carrying out procedures flexibly, accurately, efficiently and appropriately
- **Strategic competence –** ability to formulate, represent and solve problems
- **Adaptive reasoning –** capacity for logical thought, reflection, explanation and justification
- **Productive disposition –** habitual inclination to see the subject as sensible, useful and worthwhile, coupled with a belief in diligence and one's own efficacy

Part I: Teaching Statistics

According to Sowey (1995) following five important attributes of the discipline need to be brought out in teaching statistics.

1. **Coherence** in exposition can reveal in three different ways:
   - **Theme coherence –** makes the expository sequence: principle of a technique in theory, use of that technique in practice
   - **Pattern coherence –** unifies seemingly diverse topics by showing underlying similarity
   - **Knowledge coherence –** shows how statistics integrates with other disciplines
2. **Perspective** in presentation can reveal merits of a coherent exposition.
3. **Intellectual excitement** stimulates the student. It is evoked by: seeing scope for advancing the subject; observing the teacher's interest in the subject and own discovery of the subject (especially when findings are surprising).

4. The discipline's **resilience to challenging questioning** reassures the student. Reassurance comes from a clear picture of both the strengths and weaknesses of the discipline and an appreciation of how the former outweigh the latter.
5. Demonstrating **practical usefulness** implies career prospects that can fulfill the student.

Gordon (1995) views learning statistics from the student's perspective and finds three useful principles to guide teaching. Firstly, the teachers must create a supportive environment in the classroom. Classrooms should not recognize as just a place where students received instructions but a social structure in which students' action form. Secondly, guidance; is important whereas the type of guidance is critical. If the teacher is the only one in the classroom who is being creative and thoughtful, and students are expected merely to react to her or him, then the guidance will not succeed in assisting students to become independent and confident learners. Thirdly, teaching needs to build on the personal experience of the learner. Connecting abstract statistical concepts with personal experiences, analogies, smiles and metaphors may be useful instructional tools.

PART-II Statistical Problem Solving

It is observed that the subject of statistics is often illustrated with simple mathematical exercises that have no practical application. Consequently the students are unable to transfer their knowledge to real contexts. There is a need to engage the students in problem solving in an applied context.

Solving statistical problems, being foundation of the subject, is an investigative process that involves four components:

- Formulate question
- Collect data
- Analyze data
- Interpret result

According to Harradine (2004), problems are traditionally posed in ways that require students to read within, between and beyond the data. He argues that prior to teaching standard statistical tools and procedures, students should be taught the art of 'distribution division' where distributions are sliced into chunks and each chunking is considered to see what information that particular slicing configuration conveys. He also argues that application of the skills of comparing and contrasting and forming arguments that support a conclusion or conjecture should be taught prior to teaching standard statistical tools.

PART- III Time Distribution

Teaching schedules are among the integral parts of classrooms. They help the management to run and monitor the teaching of a particular subject. The following tables, indicating unit-wise time distribution, will be supportive to the teachers and education planners.

UNIT-WISE TIME DISTRIBUTION – GRADE XI

Unit	Title	Period (40 minutes each)
1.	Collection and Presentation of Data	24
2.	Measures of Central Tendency	24
3.	Measures of Dispersion, Skewness and Kurtosis	30
4.	Index Numbers	27
5.	Simple Linear Regression and Correlation	24
6.	Time Series	24
7.	Vital Statistics	24
8.	Interpolation	21
9.	Linear Programming	12
	Total:	**210**

UNIT-WISE TIME DISTRIBUTION – GRADE XII

Unit	Title	Period (40 minutes each)
1.	Probability	27
2.	Random Variables and Probability Distribution	24
3.	Special Discrete Probability Distributions	24
4.	Special Continuous Probability Distributions	24
5.	Sampling and Sampling Distribution	24
6.	Estimation	21
7.	Hypothesis Testing	24
8.	Association of Attributes	21
9.	Design of Experiment	21
	Total:	**210**

ASSESSMENT AND EVALUATION

Introduction

Assessment is the process of gathering information using a variety of tools and techniques that reflect how well a student is achieving the curriculum expectations in a subject. As part of assessment teachers provide students with descriptive feedback that guides their efforts towards improvement. The quality of assessment largely determines the quality of evaluation. Evaluation refers to the process of judgments and decisions based on the interpretation of evidence gathered through assessment.

Rowntree (1990) defined assessment as having two purposes: firstly to support and provide feedback to learners and improve their ongoing learning, and secondly to report on what they had already achieved. In essence the first is formative assessment and the second is summative assessment. Morgan and O'Reilly (1999) believe that assessment is the engine that drives and shapes learning, rather than an end of course event that grades and reports on performance.

To ensure that assessment and evaluation lead to the improvement of student learning, teachers must use specific assessment and evaluation strategies that

- Address both what students learn and how well they learn
- Are administered over a period of time and designed to provide opportunities for students to demonstrate full range of their learning,
- Ensure that each student is given clear directions for improvement,
- Promote students' ability to assess their own learning,
- Are communicated clearly to students and parents in advance.

PART-I Assessment in Statistics

It should be kept in mind that in Statistics a single type of assessment can frustrate students, diminish their self-confidence and make them feel anxious about the subject. In reality the understanding of statistical concepts encompasses a broad range of abilities. Examples of various templates to assess different abilities are mentioned below.

Assessment must include by focusing on a student's ability to:

- Communicate mathematically
- Reason and analyze, and to think and act in positive ways
- Comprehend the key concepts
- Evaluate the effectiveness of using different strategies to address the same problem
- Use a variety of strategies to problem solving and to make statistical connections
- Discriminate between relevant and irrelevant attributes of a concept in selecting examples

- Integrate and to make sense of statistical concept and procedure

Learning of Statistics, being a cumulative process, occurs as experiences contribute to understanding. Suggested below are the assessment strategies to obtain valid and reliable picture of students' understanding and achievement.

i) **Classroom-based assessments** that include anecdotal records, checklists, rating scales, portfolios peer-and self-assessment.
ii) **Teacher-designed test formats** that include oral examination, assignments/ projects/field-work, short answers, matching, multiple-choice, fill-in and true-false items.

PART-II The Traditional Examinations

Bearing in mind the requirement of simplicity in considering assessment strategies, the examinations in traditional paper-based mode with place and time-specific activities, are easy to organize for institutions (Boards of Intermediate and Secondary Education). When a formal examination, for Secondary School Certificate (SSC) or Higher Secondary School Certificate (HSSC), is used for assessment there are examination centres, infrastructure to supply and secure examination papers before examination and arrangements to check the identities of the candidates, invigilate the examination and collect the scripts for marking. Marks are then gathered and results are published in a timely manner.

For the in-house assessment and evaluation the institutions adopt their own criteria. The means by which each institution achieves quality should differ according to the circumstances in which it operates, but each must give priority to meeting students' expectations in terms of learning outcomes they can legitimately expect to achieve. In essence an effective learning-outcomes-oriented quality assurance system must be based on constant monitoring and effective learning-outcomes-oriented quality assurance system must be based on constant monitoring and effective feedback loops.

Instructions for Examining Bodies

The examining institutions or bodies including all Boards of Intermediate and Secondary Education for the conduct of HSSC examination in the subject of Statistics should follow instructions as given below.

a. The question papers should be balanced in all respect. Following table, showing weightage to difficulty level of questions, is suggested to be a practicable criterion for a balanced question paper of Statistics.

Difficulty Level of Questions	Weightage (%)
Easy	15
Average	70
Difficult	15

b. To the subject of Statistics 200 marks have been allocated for HSSC examination. There will be only two papers (Paper-A and Paper-B) of Statistics each carrying 100 marks. The students will not be assessed by the Board of Intermediate and Secondary Education (BISEs) through practical (lab work) examination.

c. The examiners will set the questions keeping in view the unit-wise weightages given below.

PART-III Unit wise Weightages

Following tables explain weightages of specified topics of Statistics for grade XI and XII.

UNIT-WISE WEIGHTAGES – GRADE XI

Unit	Title	Weightage (%)
1.	Collection and Presentation of Data	12
2.	Measures of Central Tendency	12
3.	Measures of Dispersion, Skewness and Kurtosis	14
4.	Index Numbers	12
5.	Simple Linear Regression and Correlation	12
6.	Time Series	12
7.	Vital Statistics	12
8.	Interpolation	8
9.	Linear Programming	6
	Total	**100**

UNIT-WISE WEIGHTAGES – GRADE XII

Unit	Title	Weightage (%)
1.	Probability	12
2.	Random Variables and Probability Distributions	10
3.	Special Discrete Probability Distributions	12
4.	Special Continuous Probability Distribution	12
5.	Sampling and Sampling Distribution	12
6.	Estimation	10
7.	Hypothesis Testing	12
8.	Association of Attributes	10
9.	Design of Experiment	10
	Total	**100**

TEACHING AND LEARNING RESOURCES

Introduction

Government prescribed textbook is the only teaching and learning tool used in most of the schools and colleges. Though many other resources are also available, accessible and affordable, teachers rarely use them to support the learning. In addition to the textbook, the teaching and learning resources include teacher's manual and electronic resources.

Part-I The Textbook

There are many important entities involved to revamp the entire education system. The school/college has to play its own role, parents have to contribute their share and teachers have to assume a significant place in fostering education. Print materials, particularly the textbooks, have to play a key role towards providing quality education at all levels. Although there are many stakeholders that contribute towards the overall learning of the child yet the importance of textbook as a reservoir of information/knowledge cannot be ignored.

Textbook writers have a vital role to play in penetrating the young minds through their writing. A textbook

- Whose content as well as presentation is thoughtfully planned
- Which is written by qualified and competent subject expert(s), and
- Which is attractive and engaging

must stimulate the interest of teacher and the taught.

Guidelines for Textbook Authors

Textbooks aimed at lower level tend to include more learning features than those at higher level. However in textbook writing generally the following aspects may be taken into consideration.

- The textbook should be in line with the objectives of National Curriculum
- The author should bring himself to the mental level of students he is writing for
- The span of the textbook should be fairly reasonable
- The material should not be cramped. To make it more digestible, it may be chunked into smaller parts with headings
- The textbook is expected to provide accurate and up-to-date information
- The text material should be arranged in a logical manner; simple to complex, familiar to unfamiliar and concrete to abstract
- The text material must be free from ambiguities and errors
- The content provided in the textbook should not develop wrong concepts
- The text should be clear and concise. It should not give any other meaning than the one intended
- Every table, diagram and graph should be labeled appropriately
- Footnotes and side notes may be inserted wherever necessary

Textbook Style and Structure

To make a textbook an effective teaching and learning tool its style and structure is given due importance. The material needs to be structured in a coherent and logical way, and that writing style should be reader friendly.

Unit Opening	
Unit Outline	Include list of headings
Student Learning Outcomes (SLOs)	One SLO for each heading may be included. If they are numerous then a reasonable number is acceptable.
Real Life Relevance	Illustrate the real life relevance of the unit, if possible.
Short Introduction	Explain what this unit covers and why.

Unit Body	
Key Terms	Use italics for emphasis and bold for key terms. Define key terms when first introduced and collate them with their definitions for the glossary.
Running Glossary	Key terms and definitions may be pulled out from the main body of text so that students spot them easily in the unit body (e.g. in the margins).
Feature Boxes	Regular feature boxes may include various contents such as a statistical formula or a working rule.
Illustrative Examples	Include illustrative examples to develop conceptual understanding of the topic.
Problem Sets	Special attention should be paid on preparation of Problem Sets. Correlate the topic with real life situations and include sufficient exercises on real life problems almost in every problem set, if appropriate.
Learning Review Points	Include bulleted questions for students to check their understanding at regular intervals. Possible labels include 'self-test point' or 'checkpoint'.
Tips or Hints	Separated from the main body of text, they allow the author to speak directly to the student, offering useful advice or flagging important points.
Visuals	Tables, graphs, diagrams and lists may be used to break up the text.

Unit Ending	
Problem Set (Review)	Include multiple-choice questions, interpretive exercises and fill-in items. Students may also be asked to label diagrams or write a one word answer to short question.
Summary	Include a review of the main concepts. This can relate to the SLOs by covering each in turn (bullet points work well). The summary should not include any new information.

End of Textbook	
Glossary	Include only the key terms in the glossary.
Answers to Problems	Include answers to the problem sets unit wise.
Appendices	Include extra information the student needs such as list of statistical formulas, log tables and relevant websites.
Bibliography	Include bibliography and list of books for suggested reading where appropriate.
Index	Include index for the key terms used in the book

PART-II The Teacher's Manual

Ideally the teacher's manual should come with the textbook. The manual is aimed at informing teachers how the textbook is written and how best to use it to facilitate student learning. It can be seen as a means of helping teachers develop professionally. It provides details explanation of key concepts and the way to teach a particular topic. Its basic features are as below.

The teacher's manual should

- Be easy to understand and use
- Help teachers teach text and extend activities
- Give sequenced instructions for each activity
- Include teaching learning resources
- Establish a question bank (having questions different from text) and suggest interactive quizzes corresponding to each unit.
- Involve various up-to-date and relevant teaching strategies and rationale for suggested teaching
- Explain how to implement each teaching strategy
- Identify constraints and strengths of each strategy or activity

- Identify resources needed for teaching strategies and extension of activities
- Expand and develop teachers repertoire of knowledge and skills
- Identify assessment strategies

PART-III The Web-based Resources

The World Wide Web is growing very fast to access an immense volume of rapidly evolving information. It is acting as a driving force since its ease of use makes the internet trivially accessible. Through web-based links like the ones mentioned below the teachers and students can access

- Various sites around the world
- Additional information and currency on the topics

Title of Website	**Universal Resource Locator (URL)**
Analyse-it	http://www.analyse-it.com
Data Analysis and Probability	http://www.mste.uiuc.edu/stat/stat.html
Electronic Encyclopaedia of Statistical Examples & Exercises	http://www.whfreeman.com/eesee/eesee.html
Exploring Data	http://exploringdata.cqu.edu.au
Online Statistics	http://onlinestatbook.com
Pink Monkey.Com Statistics Study Guide	http://www.pinkmonkey.com/studyguides/subject /stat/contents.asp
Rice Virtual Lab in Statistics	http://onlinestatbook.com/rvls.html
Shodor Education Foundation (Interactivate)	http://www.shodor.org/interactivate/lessons/
SPSS	http://www.spss.com
Statistica	http://www.statsoft.com
MAPLE	http://www.maplesoft.com
MATHEMATICA	http://www.wolfram.com/products/mathematica/ index.htm.
Minitab	http://www.minitab.com/products/Minitab/

REFERENCES

1. Burrill,G. (2005): Curriculum issues in Statistics Education, in the 8th International Conference of Mathematics Education into the 21st Century Project: 'Reform, Revolution and Paradigm Shifts in Mathematics Education'.

2. Cobb, G.W., and Moore, D.S. (1997): Mathematics, Statistics, and Teaching, The American Mathematical Monthly, Vol 104, No.9, pp. 801-823.

3. Kilpatrick,J., Swafford, J., and Findell, B. (Eds) (2001): Adding it up: Helping children learn mathematics, Mathematics Learning Study Committee, Centre for Education, Washington, DC: National Academies Press.

4. Franklin, C., Horton, N. Kader, G., Moreno, J., Murplhy, M., Snider, V., Stames, D. (2005): Guidelines for Assesment andInstruction in Statistics Education (GAISE) Report, American Statistical Association, Alexandria VA: http:// www. amstat. org/ education/gaise.

5. Gordon, S., (195): A theoretical approach to understanding earners of statistics, Journal of Statistics Education, Vol 3, No.3.

6. Green, D. (1994): Teaching Statistics at its bet, Teaching Statistics Trust, University of Sheffield England.

7. Harradine, A. (2004): Within, between and beyond, Curriculum Development in Statistics Education, Round Table IASE, Lund, Sweden.

8. Morgan, C., and O'Reilly, M. (1999): Assessing open and distance learners, Kogan Page, London.

9. National Curriculum of Mathematics (2006): Curriculum Wing, Ministry of Education, Government of Pakistan, Islamabad.

10. NCTM (2000): Principals and standards for school mathematics, National Council for Teachers of Mathematics, Reston, VA.

11. NCTM (2006): Thinking and reasoning with data and chance: 68th NCTM Yearbook, National Council for Teachers of Mathematics. Reston, VA.

12. Rowntree, D.(1990): Teaching through self-instruction (Second Ed), Kogan Page. London.

13. Sowey, Eric R. (1995): Teaching statistics: Making it memorable, Journal of Statiics Education, Vol 3, No.2.

CURRICULUM DEVELOPMENT TEAMS

▪ Team of Curriculum Writers

Professor Dr. Muhammad Tahir
Consultant (Sciences), Ministry of Education, Islamabad. (Supervisor and Coordinator)

Professor Dr. Muhammad Aslam
Chairman Department of Statistics
Quaid-i-Azam University
Islamabad

Mr. Muhammad Rauf Chaudhry
Associate Professor ® of Statistics
Government Postgraduate College
Gujranwala

Mr. Muhammad Riaz Chaudhry
Principal/Associate Professor of Statistics
Government Degree College
Kharian

Dr. Malik Muhammad Yousaf
Associate Professor
Department of Mathematics
Quaid-i-Azam University
Islamabad

▪ Team of Advisors

Professor Dr. Munir Ahmad (Focal Person)
Rector/Professor of Statistics
National College of Business
Administration & Economics,
Gulberg-III, Lahore.

Professor Dr. Muhammad Aslam
Chairman Department of Statistics
Quaid-i-Azam University,
Islamabad.

Professor Dr. Faqir Muhammad
Chairman Statistics & Mathematics
Department
Allama Iqbal Open University,
Islamabad.

Prof. Dr. Junaid Sagheer Siddiqui
Chairman Department of Statistics
University of Karachi
Karachi.

Professor Dr. Salah-ud-Din
Department of Statistics
University of Peshawar
Peshawar

Dr. S.M. Hussain Bukhari
Joint Director
Statistics & Data Warehouse Department
State Bank of Pakistan
Karachi

Dr. Muhammad Aleem
Chairman Department of Statistics
Islamia University
Bahawalpur

Sardar Iftikhar Ahmed
Chairman Department of Statistics
Government Postgraduate College
Rawalakot (AJ&K)

- **Team of Examination Experts**

Mr. Gulzar Ahmad Bhatti
Associate Professor Statistics
Government Postgraduate College
Bahawalnagar

Mrs Farkhanda Nasreen
Associate Professor of Statistics
Government Girls College
Mastung (Balochistan)

Mr. Tariq Mehmood Mirza
Assistant Professor of Statistics
Government Islamia College Railway Road
Lahore

Mr. Irfan Ullah
Assistant Professor of Statistics
Government Postgraduate College
Nowshera

Mr. Iftikhar ud Din
Assistant Professor of Statistics
Government Degree College, Hayatabad,
Peshawar.