

Contents

<i>Preface</i>	(vii)
----------------------	-------

CHAPTER 1

An Overview of Statistical Applications

1.1 Introduction	1
1.2 Probability Functions and Statistics	2
1.2.1 Discrete versus Continuous Functions	2
1.2.2 Distributions Describing Randomness	2
1.2.3 Data Organization	3
1.2.4 Common Statistical Estimators	3
1.2 Applications of Normal Distribution.....	5
1.2.1 The Standard Normal Distribution.....	6
1.2.2 Characteristics of the Normal Distribution Function	6
1.3 Confidence Bounds	6
1.4 Determination of Sample Size.....	8
1.5 Random Variables Summation.....	9
1.5.1 The Central Limit Theorem	9
1.6 The Binomial Distributions	11
1.6.1 Bernoulli and the Binomial Distribution.....	11
1.6.2 Asking People Questions Survey Results	12
1.6.3 The Binomial and the Normal Distributions	13
1.7 The Poisson Distribution	13
1.8 Testing of Hypotheses	14
1.8.1 Before-and-After Tests with Two Distinct Choices.....	14
1.8.2 Before-and-After Tests with Generalized Alternative Hypothesis.....	17
1.8.3 Other Useful Statistical Tests.....	19
1.9 Summary.....	21

CHAPTER 2**Preliminaries**

2.1	Introduction	22
2.2	Basic Concepts	25
2.2.1	Characteristics	25
2.2.2	Attributes	25
2.2.3	Variables	25
2.2.4	Numeric Variables	25
2.2.5	Categorical Variables	26
2.2.6	Data	26
2.2.7	Classification and Tabulation	27
2.3	Tabulation of Data	28
2.4	Frequency Distribution	30
2.4.1	Simple Frequency Distribution	30
2.4.2	Grouped Frequency Distribution	30
2.5	Cumulative Frequency Table	33
2.5.1	Less than Cumulative Frequency Table	33
2.5.2	More than Cumulative Frequency Table	34
2.6	Measures of Central Tendency	34
2.7	Arithmetic Mean	35
2.7.1	Simple Arithmetic Average	35
2.7.2	Weighted Arithmetic Mean	36
2.7.3	Merits of Arithmetic Mean	39
2.7.4	Demerits of Arithmetic Mean	39
2.7.5	Properties of Mean	39
2.7.6	Statistical Applications to Transportation Engineering	44
2.8	Median	46
2.8.1	Merits of Median	48
2.8.2	Demerits of Median	48
2.9	Mode	50
2.9.1	Merits of Mode	54
2.9.2	Demerits of Mode	54

2.10	Geometric Mean	57
2.10.1	Merits of Geometric Mean	58
2.10.2	Demerits of Geometric Mean.....	59
2.11	Harmonic Mean	61
2.11.1	Merits of Harmonic Mean.....	62
2.11.2	Demerits of Harmonic Mean.....	62
2.11.3	Relation between A.M, G.M and H.M.....	62
2.12	Partition Values (Quartiles, Deciles and Percentiles).....	66
2.12.1	Quartiles	66
2.12.2	Deciles.....	68
2.12.3	Percentiles	68
2.13	Measures of Dispersion	70
2.13.1	Characteristics of an Ideal Measure of Dispersion.....	71
2.13.2	Types of Measures of Dispersion.....	71
2.14	Range.....	71
2.14.1	Coefficient of Range	72
2.14.2	Merits of Range.....	72
2.14.3	Demerits of Range.....	72
2.14.4	Uses of Range	72
2.15	Inter-Quartile Range	73
2.16	Quartile Deviation	73
2.16.1	Coefficient of Quartile Deviation.....	73
2.17	Mean Deviation	76
2.17.1	Coefficient of Mean Deviation.....	77
2.17.2	Merits of Mean Deviation	79
2.17.3	Demerits of Mean Deviation.....	79
2.18	Standard Deviation	80
2.18.1	Coefficient of Standard Deviation	82
2.18.2	Merits of Standard Deviation	83
2.18.3	Demerits of Standard Deviation.....	83

CHAPTER 3

Probability

3.1	Introduction	86
3.2	Classical Probability	88
3.2.1	Properties of Classical Probability	88
3.2.2	Probability of Failure	89
3.3	Relative Frequency Approach of Probability	89
3.4	Symbolic Notation.....	92
3.5	Axiomatic Theory of Probability	92
3.6	Independent and Dependent Events	94
3.7	Conditional Probability	95
3.8	Multiplication Theorem on Probability	95
3.9	Baye's Theorem (Statement)	97

CHAPTER 4

Random Variables

4.1	Introduction	100
4.2	Discrete Random Variable.....	101
4.3	Probability Distribution for a Discrete Random Variable	102
4.3.1	Probability Mass Function	102
4.3.2	Distribution Function	103
4.3.3	Additional Properties of Distribution Function.....	104
4.4	Mean and Variance of a Discrete Distribution	106
4.5	Continuous Random Variable	112
4.6	Probability Density Function.....	112
4.7	Cumulative Distribution Function	112
4.8	Mean and Variance of a Continuous Random Variable	114
4.9	Joint Distributions	121
4.9.1	Joint Probability Function.....	122
4.9.2	Joint Probability Distribution of Discrete Random Variables....	122
4.9.3	Marginal Probability Function of a Discrete Random Variables.....	123
4.9.4	Joint Distributive Function of Discrete Random Variables	123

4.10	Conditional Probability Distribution	125
4.11	Independent Random Variables.....	126
4.12	Joint Probability Function of Continuous Random Variables	128
4.13	Joint Probability Distribution Function of Continuous Random Variables	128
4.14	Marginal Distribution Function	129
	4.14.1 Marginal Density Functions.....	129
4.15	Conditional Probability Density Functions	130
4.16	Mathematical Expectation and Moments	136
	4.16.1 Properties of Mathematical Expectation	137
	4.16.2 Variance	141
	4.16.3 Properties of Variance.....	141
	4.16.4 Covariance	154
4.17	Moments	159
	4.17.1 Moments about an Arbitrary Number	160
	4.17.2 Moments about Origin	162
	4.17.3 Skewness and Kurtosis.....	162
4.18	Moment Generating Function.....	169
4.19	Properties of Moment Generating Function	170
4.20	Discrete Probability Distributions	176
	4.20.1 Binomial Distribution.....	177
	4.20.2 Expected Frequencies and Filling of a Binomial Distribution....	178
	4.20.3 Recurrence Relation.....	178
	4.20.4 Moments, Skewness and Kurtosis of the Binomial Distribution.....	179
	4.20.5 Moment Generating Function of a Binomial Distribution	181
	4.20.6 Characteristics of a Binomial Distribution.....	182
4.21	Poisson Distribution	196
	4.21.1 Conditions under which Poisson Distribution is used.....	197
	4.21.2 Poisson Probability Function	197
	4.21.3 Poisson Frequency Distribution	199
	4.21.4 Moment of a Poisson Distribution	200
	4.21.5 Recurrence Relation.....	201

4.21.6	Characteristics of Poisson Distribution	202
4.21.7	Moment Generating Function of the Poisson Distribution	202
4.21.8	Reproductive Property of the Poisson Distribution.....	202
4.22	Discrete Uniform Distribution.....	219
4.23	The Negative Binomial and Geometric Distribution.....	219
4.24	Geometric Distribution.....	220
4.25	Continuous Probability Distributions	221
4.26	Uniform Distribution	221
4.26.1	Moments of the Uniform Distribution	222
4.26.2	Mean of Uniform Distribution	223
4.26.3	Variance of Uniform Distribution	223
4.26.4	Moment Generating Function of the Uniform Distribution	223
4.27	Exponential and Negative Exponential Distribution	225
4.28	Normal Distribution.....	225
4.28.1	Standard Normal Variable.....	226
4.28.2	Distribution Function (z) of Standard Normal Variate	227
4.28.3	Area under Normal Curve	227
4.28.4	Area under Standard Normal Curve.....	228
4.28.5	Properties of Normal Curve	228
4.28.6	Mean of Normal Distribution.....	229
4.28.7	Variance of Normal Distribution	229
4.28.8	Mode of Normal Distribution.....	230
4.28.9	Median of the Normal Distribution.....	231
4.28.10	Moment Generating Function of Normal Distribution with Respect to Origin	232
4.28.11	Mean Deviation of Normal Distribution	233
4.28.12	Fitting a Normal Distribution.....	242
4.28.13	Linear Combination of Independent Normal Variables	249
4.28.14	Fitting a Normal Distribution.....	249
4.28.15	Normal Approximation to Binomial Distribution.....	253
4.29	Characteristic Function.....	257
4.30	Gamma Distribution	257
4.30.1	Mean and Variance of Gamma Distribution	258
4.30.2	Gamma Distribution of Second Kind.....	258

4.31	Beta Distribution of First Kind.....	258
4.31.1	Beta Distribution of Second Kind.....	259
4.32	Weibull Distribution.....	259

CHAPTER 5

Curve Fitting

5.1	Introduction	262
5.2	The Method of Least Squares.....	262
5.3	The Least-Squares Line	263
5.4	Fitting a Parabola by the Method of Least Squares.....	265

CHAPTER 6

Correlation and Regression

6.1	Introduction	273
6.2	Correlation.....	273
6.2.1	Types of Correlation	274
6.3	Coefficient of Correlation.....	274
6.3.1	Properties of Coefficient of Correlation.....	274
6.4	Methods of Finding Coefficient of Correlation	275
6.5	Scatter Diagram	275
6.6	Direct Method.....	276
6.7	Spearman's Rank Correlation Coefficient.....	281
6.8	Calculation of r (Correlation Coefficient) (Karl Pearson's Formula).....	284
6.9	Regression	285
6.10	Regression Equation	286
6.11	Curve of Regression	286
6.12	Types of Regression	286
6.13	Regression Equations (Linear Fit)	286
6.13.1	Linear Regression Equation of y on x	286
6.13.2	Regression Equation of x and y	288
6.14	Angle between Two Lines of Regression.....	289
6.15	Coefficient of Determination.....	291

(xvi) *Contents*

6.16	Coefficient non-Determination.....	291
6.17	Coefficient of Alienation.....	291
6.18	Multi Linear Regression	301
6.19	Uses of Regression Analysis	302

CHAPTER 7

Sampling

7.1	Introduction	308
7.2	Population.....	308
7.3	Sample	308
7.4	Sampling.....	309
7.5	Random Sampling	309
7.6	Simple Random Sampling.....	309
7.7	Stratified Sampling.....	310
7.8	Systematic Sampling	310
7.9	Sample Size Determination	311
7.10	Sampling Distribution	312

CHAPTER 8

Hypothesis Testing

8.1	Introduction	316
8.2	Hypothesis	316
8.3	Hypothesis Testing	316
8.4	Types of Hypothesis.....	317
8.4.1	Null Hypothesis.....	317
8.4.2	Alternative Hypothesis.....	317
8.5	Computation of Test Statistic	317
8.6	Level of Significance.....	318
8.7	Critical Region.....	318
8.8	One Tailed Test and Two Tailed Tests.....	318
8.8.1	One Tailed Test	318
8.8.2	Two-Tailed Test.....	319

8.9	Errors	321
8.10	Procedure for Hypothesis Testing	322
8.11	Important Tests of Hypothesis.....	323
8.12	Critical Values	323
8.13	Test of Significance – Large Samples	324
8.13.1	Test of Significance for Single Mean.....	324
8.13.2	Test of Significance for Difference of Means of Two Large Samples.....	330
8.13.3	Test of Significance for the Difference of Standard Deviations of Two Large Samples.....	335
8.14	Test of Significance for Single Proportion	344
8.15	Testing of Significance for Difference of Proportions	352

CHAPTER 9

Chi-Square Distribution

9.1	Introduction	359
9.2	Contingency Table.....	360
9.3	Calculation of Expected Frequencies	360
9.4	Chi-Square-Distribution	361
9.4.1	Characteristic Function of χ^2 distribution.....	362
9.5	Mean and Variance of χ^2 (Chi-Square).....	362
9.6	Additive Property of Independent Chi-Square Variate	363
9.7	Degrees of Freedom	368
9.8	Conditions for Using χ^2 (Chi-Square) Test.....	368
9.9	Uses of χ^2 (Chi-Square) Test	368
9.9.1	χ^2 (Chi-Square) Test as a Test of Goodness of Fit	369
9.9.2	Test for Independence of Attributes.....	375
9.9.3	Homogeneity Chi-Square.....	382
9.9.4	χ^2 (Chi-Square) Distribution of Sample Variance	382
9.9.5	Testing a Hypothesis about the Variance of Normally Distributed Population – Decision Rule	382

(xviii) *Contents*

CHAPTER 10

Test of Significance – Small Samples

10.1	Introduction	391
10.2	Moments about Mean	393
10.3	Properties of Probability Curve	395
10.4	Assumptions for t-Test	395
10.5	Uses of t-Distribution	395
10.6	Interval Estimate of Population Mean	396
10.7	Types of t-Test	396
10.8	Significant Values of t	396
10.9	Test of Significance of a Single Mean	397
10.10	Student's t-Test for Difference of Means	405
10.11	Paired t-Test	417
10.12	F-Distribution	419

CHAPTER 11

ANOVA (Analysis of Variance)

11.1	Introduction	429
11.2	Assumptions	430
11.3	One Way ANOVA	430
11.4	Working Rule	435

CHAPTER 12

Analysis of Time Series

12.1	Introduction	440
12.2	Purpose of Time Series Study	441
12.3	Editing of Data	441
12.4	Components of Time Series	442
12.5	Mathematical Model for a Time Series	443
12.6	Methods of Measuring Trend	443
	12.6.1 Free-Hand Method	443
	12.6.2 Semi-Average Method	444

12.6.3	Moving Average Method	447
12.6.4	Method of Least Square	451
12.6.5	Non-Linear Trend	456
12.6.6	Conversions of Trend Equations.....	459

CHAPTER 13

Index Numbers

13.1	Introduction	466
13.2	Definitions and Characteristics.....	466
13.2.1	Definition	466
13.2.2	Characteristics	467
13.2.3	Uses.....	467
13.3	Types of Index Numbers.....	468
13.4	Problems in the Construction of Index Numbers.....	468
13.5	Method of Constructing Index Numbers.....	470
13.6	Tests for Consistency of Index Numbers	491
13.6.1	Time Reversal Test	491
13.6.2	Factor Reversal Test.....	493
13.6.3	Circular Test.....	497
13.7	Quantity Index Numbers	498
13.8	Consumer Price Index Number	499
13.9	Utility of Consumer Price Index Number.....	499
13.10	Formulas for Constructing Consumer Price Index	500
13.11	Chain Base Method	502
13.12	Base Conversion	504
13.12.1	Base Conversion	504
13.12.2	Base Shifting	506
13.13	Splicing.....	507
13.14	Deflation.....	509
Index.....		515