Government of Karnataka

Curriculum Framework for Undergraduate Programme in Colleges and Universities of Karnataka State.

3rd & 4th Semester Model Syllabus for BSc in STATISTICS

Submitted to
Vice Chairman
Karnataka State Higher Education Council
30, Prasanna Kumar Block, Bengaluru City University Campus,
Bengaluru, Karnataka – 560009

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4	Dr Sujata Inginshetty Professor and Chairperson, Department of Statistics Gulbarga University, Kalaburgi	Member
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Model Curriculum

of

BSc

in

STATISTICS

3rd & 4th Semester

Karnataka State Higher Education Council

Government of Karnataka

Model Curriculum

Program Name	**BA/BSc/BCom in STATISTICS**	Semester	**3**
Course Title	**CALCULUS AND PROBABILITY DISTRIBUTIONS(Theory)**		
Course Code:		No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Judge continuity of a function, find integrations and solve problems of differentiability.

CO2. Define and describe properties of Joint, Marginal and conditional distributions of variables and some key concepts of probability theory.

CO3. Understand different discrete, continuous and sampling distributions, properties and their applications.

CO4. Solve problems of various analytical environments using different distributions and their properties.

CO5. Find sampling distributions of functions of random variables and explore their applications.

Contents	**60 Hrs**
UNIT 1: Calculus of one and more variables	15 Hrs
Review of calculus of one variable: continuity, differentiability, mean value theorem and Taylor series expansion. Functions of several variables: Continuity, directional derivatives, differentials of functions of several variables, the gradient vector. The mean value theorem, a sufficient condition for the existence of the differential, partial derivatives of higher order and Taylor's formula. Applications of partial differentiation, Jacobians. Riemann integrals, integration by parts, mean value theorem. Multiple integrals and evaluation of multiple integrals by repeated integration, Mean-value theorem for multiple integrals. Sequences and Series of real numbers. convergence of sequences and series, tests for convergence of series. (Only results and applications)	

UNIT 2: Distribution of Random Variables (Two-dimensional)	15 Hrs
Two dimensional random variables: Joint distribution, Marginal distribution and Conditional distributions of random variables, conditional expectation, covariance, correlation and moments. Distribution of functions of random variables using m.g.f. and distribution function. Transformation of variable technique (one and two variables). Chebyshev's inequality- proof and its use in approximating probabilities; Statements of Weak Law of Large Numbers; Convergence in law and Central Limit theorems – De-Moivre. (Some simple examples)	
UNIT 3: Probability Distributions-II	15 Hrs
Discrete distributions: Geometric, Negative Binomial, Hypergeometric, Multinomial- definition through probability mass function, mean, variance, moments, p.g.f., m.g.f., other properties and applications. Continuous distributions: Uniform, Gamma, Exponential, Beta (type 1 and type 2), Cauchy, Weibull– definition through probability density function, mean, variance, moments, m.g.f., other properties and applications. Bivariate normal distribution- definition through probability density function, marginal and conditional distribution.	
UNIT 4: Sampling Distributions and Simulation	15 Hrs
Definitions of random sample, parameter and statistic, sampling distribution of sample mean, standard error of sample mean, sampling distribution of sample variance, standard error of sample variance. Exact sampling distributions: Chi square distribution- mean, variance, moments, mode, additive property. Student's and Fisher's t-distribution- mean, variance, moments and limiting form of t distribution. Snedecor's F-distribution: mean, variance and mode. Distribution of 1/F. Relationship between t, F and χ^2 distributions. Introduction to simulation. Generation of random observations from Uniform, Exponential, Normal, Binomial, Poisson distributions using R-codes.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Judge continuity of a function, find integrations and solve problems of differentiability.															

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Define and describe properties of Joint, Marginal and conditional distributions of Variables and some key concepts of probability theory.															
Understand different discrete, continuous and sampling distributions, properties and their applications.															
Solve problems of various analytical environments using different distributions and their properties.															
Find sampling distributions of functions of random variables and explore their applications.															

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per University guidelines are compulsory	

Course Title	**Calculus and Probability Distributions (Practical)**	Practical Credits	**2**
Course Code		Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**
Practical Content			
1. Demonstration of R functions for calculus, distribution of random variables, probability distributions, sampling distribution simulation.			

2. Numerical differentiation and integration.
3. Bivariate Probability Distributions - Marginal and Conditional distributions,
4. Bivariate Probability Distributions - Conditional Mean, Conditional Variance, Correlation.
5. Applications of Chebyshev's inequality (For standard distributions such as Normal, Exponential, Gamma).
6. Applications of discrete probability distributions - Negative – Binomial, Geometric, Hyper geometric and discrete uniform, multinomial distributions.
7. Applications of continuous probability distributions - Exponential, Gamma, Cauchy, Weibull distributions.
8. Fitting of discrete and continuous distributions.
9. Generating random sample from discrete distributions.
10. Generating random sample from continuous distributions.

Pedagogy: The first practical assignment is on R-programming. Practical assignments 2 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**
Formative Assessment as per University guidelines are compulsory	

References	
1	Andre I Khuri (2003). Advanced Calculus with Applications in Statistics, Second Edition, John Wiley & Sons.
2	Ghorpade, S. R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis, Springer
3	Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
4	Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
5	Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference,10th Edition, Pearson Education, New Delhi.
6	Jay Kerns, G. (2010). Introduction to Probability and Statistics using R. 1st Edition, Springer.
7	Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002). An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.
8	Ross, S. M. (2014). Introduction to Probability Models. 11th Edition, Elsevier science.

References	
9	Ross, S. M. (2012). Simulation. Academic Press.
10	Shanthi Narayana (2000), Integral Calculus, S. Chand & Co. Ltd.
11	Shanti Narayana (2000). Differential Calculus, S. Chand & Co. Ltd.
12	Verzani, J. (2002). Simple R - Using R for Introductory Statistics.

Government of Karnataka

Model Curriculum

Program Name	**BA/BSc/BCom in STATISTICS**	Semester	**4**
Course Title	**STATISTICAL INFERENCE-I (Theory)**		
Course Code:		No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1.Carryout statistical analysis by identifying families of distributions and the use of order statistics.

CO2.Find estimators using different methods of estimation and compare estimators.

CO3.Carryout statistical inference using different tests of hypotheses under different scenarios.

CO4.Learn Estimation, criteria for estimators, methods of estimation, confidence interval.

CO5.Generate random variables and use these generated random variables for illustration of concepts studied in this course.

Contents	**60 Hrs**
UNIT- 1: Point Estimation-I	**15 Hrs**
Families of distributions- location and scale families. Single parameter exponential family. Concept of order statistics, Distribution of maximum and minimum order statistics (with proof) and r^{th} order statistic (without proof). Concepts of estimator and estimate. Criteria for estimators: Unbiasedness, Consistency. Invariance property of consistent estimators. Efficiency and relative efficiency. Mean squared error as a criterion for comparing estimators. Sufficient statistics. Neyman-Factorization theorem. (Statement and applications).	
UNIT-2: Point Estimation-II	**15 Hrs**
Fisher information function. Statement of Cramer–Rao inequality and its applications. Minimum Variance Unbiased Estimator and Minimum Variance Bound Estimator. Rao-Blackwell theorem(Statement and applications). Maximum likelihood and method of moment estimation; Properties of MLE and moment estimators and examples.	

UNIT- 3: Testing of Hypotheses	**15 Hrs**
Statistical hypotheses - null and alternative, Simple and composite hypotheses. Type-I and Type-II errors, test functions. Randomized and non-randomized tests. Size, level of significance, Power function, power of tests. Critical region, p- value and its interpretation. Most Powerful (MP) test, Statement of Neyman-Pearson Lemma and its applications.	
UNIT- 4:Tests of Significance and Interval Estimation	**15 Hrs**
Large and small samples tests of significance. Tests for single mean, equality of two means, single variance and equality of two variances for normal populations. Tests for proportions. Confidence interval, confidence coefficient, shortest confidence interval. Methods of constructing confidence intervals using pivotal quantities. Construction of confidence intervals for mean, difference of two means, variance and ratio of variances, proportions, difference of two proportions.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-15)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Carryout statistical analysis by identifying families of distributions and the use of order statistics.															
Find estimators using different methods of estimation and compare estimators.															
Carryout statistical inference using different tests of hypotheses under different scenarios.															
Learn Estimation, criteria for estimators, methods of estimation, confidence interval.															
Generate random variables and use these generated random variables for illustration of concepts studied in this course.															

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per University guidelines are compulsory	

Course Title	**Statistical Inference-I (Practical)**	Practical Credits	**2**
Course Code	**XXXX**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Demonstration of R-functions for estimation and testing of hypotheses.
2. Point estimation of parameters and obtaining estimate of standard errors and mean square error.
3. Computing maximum likelihood estimates.
4. Computing moment estimates.
5. Interval estimation: Construction of confidence interval (large and small samples)
6. Evaluation of Probabilities of Type – I and Type – II errors and power of tests.
7. Small sample tests: Tests for mean, equality of means under normality when variance is (i) known (ii) unknown, P-values.
8. Small sample tests: single proportion and equality of two proportions, variance and equality of two variances under normality. P-values for the above tests.
9. Large sample tests: Tests for mean, equality of means when variance is (i) known (ii) unknown, under normality, variance and equality of two variances under normality. P-values for the above tests.
10. MP and UMP tests for parameters of binomial, Poisson distributions, normal and Exponential (scale parameter only) distributions and power curve.

Pedagogy: The first practical assignment is on R-programming. Practical assignments 2 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment: Total 25 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	25

References	
1	Casella and Berger (2002), Statistical Inference, Duxbury advanced series, 2nd Edition
2	Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
3	Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
4	Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, 10th Edition, Pearson Education, New Delhi.
5	Kale, B.K. (1999). A First Course on Parametric Inference, New Delhi, Narosa Publishing House.
6	Kendall, M.G., et. al., (1996). An Introduction to the Theory of Statistics, Universal Book Stall.
7	Rohatgi, V.K. and A.K. Md. Ehsanes Saleh. (2002). An Introduction to Probability Theory and Mathematical Statistics, New York, John Wiley.

List of Open Elective (OE) for first two semesters

1) Statistical Methods
2) Business Statistics
3) Applied statistics
4) Biostatistics

List of Open Elective (OE) for III and IV semesters

1) Population Studies
2) Survival Models
3) Operations Research
4) Quantitative Analysis Techniques

1. Statistical Methods (Open Elective)

Course Objectives

1. This is an open elective course for other than statistics students.
2. The students will learn the elements of descriptive statistics, probability, statistical methods such as tests of hypotheses, correlation and regression.

Course Outcomes

Students will be able to

CO1. Acquire knowledge of statistical methods.

CO2. Identify types of data and visualization, analysis and interpretation.

CO3. Know about elementary probability and probability models.

CO4. Employ suitable test procedures for given data set.

Pedagogy

The course is taught using traditional chalk and talk method using problem solving through examples and exercises. Students are encouraged to use resources available on open sources.

Contents

Unit 1: Introduction **10 Hours**

Definition and scope of Statistics. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives. Concepts of statistical population and sample. Sampling from finite population - Simple random sampling, Stratified and systematic random sampling procedures (definitions and methods only). Concepts of sampling and non-sampling errors.

Unit 2: Univariate and Bivariate Data Analysis **10 Hours**

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.

Bivariate data, scatter diagram, Correlation, Karl-Pearson's correlation coefficient, Rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

Unit 3: Probability and Distributions **12 Hours**

Probability: Random experiment, trial, sample space, events-mutually exclusive and exhaustive events. Classical, statistical and axiomatic definitions of probability, addition and multiplication theorems, Bayes theorem (only statements). Discrete and continuous random variables, probability mass and density functions, distribution functions, expectation of a random variable.

Standard univariate distributions: Binomial, Poisson and Normal distributions (Elementary properties and applications only).

Unit 4: Sampling Distributions and Testing of Hypothesis **10 Hours**

Distribution of sample mean from a normal population, Chi-square, t and F distributions (No derivations) and their applications.

Statistical Hypothesis – null and alternative hypothesis, simple and composite hypothesis. Type I and Type II errors, level of significance, critical region, P-value and its interpretation.

Test for single mean, equality of two means, single variance, and equality of two variances for normal populations.

References

1. Daniel, W. W. (2007 Biostatistics - A Foundation for Analysis in the Health Sciences, Wiley
2. T.W. Anderson and Jeremy D. Finn(1996). The New Statistical Analysis of Data, Springer.
3. Mukhyopadyaya P(1999). Applied Statistics, New Central book Agency, Calcutta.
4. Ross, S.M.(2014) Introduction to Probability and Statistics For Engineers and Scientists.
5. Cochran, W G (1984): Sampling Techniques, Wiley Eastern, New Delhi.

2. Business Statistics (Open Elective)

Course Objectives

1. Provide an introduction to basics of statistics within a financial context.
2. To enable students to use statistical techniques for analysis and interpretation of business data.

Course Outcomes (CO)

Upon the completion of this course students should be able to:

CO1.Frame and formulate management decision problems.

CO2. Understand the basic concepts underlying quantitative analysis.

CO3.Use sound judgment in the applications of quantitative methods to management decisions.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Contents

Unit 1: Statistical Data and Descriptive Statistics **12 Hours**

Nature and Classification of data: univariate, bivariate and multivariate data; time-series and cross-sectional data. Measures of Central Tendency: mathematical averages including arithmetic mean geometric mean and harmonic mean, properties and applications. Positional Averages Mode and Median (and other partition values including quartiles, deciles, and percentiles). Measures of Variation: absolute and relative. Range, quartile deviation, mean deviation, standard deviation, and their coefficients, Properties of standard deviation/variance Skewness: Meaning, Measurement using Karl Pearson and Bowley's measures; Concept of Kurtosis.

Unit 2: Simple Correlation and Regression Analysis **10 Hours**

Correlation Analysis: Meaning of Correlation: simple, multiple and partial; linear and non-linear, Correlation and Causation, Scatter diagram, Pearson's co-efficient of correlation; calculation and properties (Proof not required). Correlation and Probable error; Rank Correlation.

Regression Analysis: Principle of least squares and regression lines, Regression equations and estimation; Properties of regression coefficients; Relationship between Correlation and Regression coefficients; Standard Error of Estimate and its use in interpreting the results.

Unit 3: Index Numbers **10 Hours**

Definition, Problems involved in the construction of index numbers, methods of constructing index numbers of prices and quantities, simple aggregate and price relatives method, weighted aggregate and weighted average of relatives method, important types of weighted index numbers: Laspeyre's, Paasche's, Bowley's, Marshall- Edgeworth, Fisher's, method of obtaining price and quantity index numbers, tests consistency of index numbers, time reversal test and factor reversal test for index numbers, Uses and limitations of index numbers. Consumer price index number: Problems involved in the construction of cost of living index number, advantages and disadvantages, Aggregative expenditure method and Family budget method for the construction of consumer price index numbers. Applications of Cost of Living Index numbers. Definition and measurement of Inflation rate – CPI and GNP Deflator.

Unit 4: Time Series Analysis **10 Hours**

Introduction, definition and components of Time series, illustrations, Additive, Multiplicative and mixed models, analysis of time series, methods of studying time series: Secular trend, method of moving averages, least squares method – linear, quadratic, exponential trend fittings to the data. Seasonal variation - definition, illustrations, measurements, simple average method, ratio to moving average method, ratio of trend method, link relatives method, Cyclical variation- definition, distinction from seasonal variation, Irregular variation- definition, illustrations.

References

1. Levin, Richard, David S. Rubin, Sanjay Rastogi, and H M Siddiqui. Statistics for Management. 7th ed., Pearson Education.
2. David M. Levine, Mark L. Berenson, Timothy C. Krehbiel, P. K.Viswanathan, Business Statistics: A First Course, Pearson Education.
3. Siegel Andrew F. Practical Business Statistics. McGraw Hill Education.
4. Gupta, S.P., and Archana Agarwal. Business Statistics, Sultan Chand and Sons, New Delhi.
5. Vohra N. D., Business Statistics, McGraw Hill Education.

6. Murray R Spiegel, Larry J. Stephens, Narinder Kumar. Statistics (Schaum's Outline Series), Mc-Graw Hill Education.
7. Gupta, S.C. Fundamentals of Statistics. Himalaya Publishing House.
8. Anderson, Sweeney, and Williams, Statistics for Students of Economics and Business, Cengage Learning.

3. Applied Statistics (Open Elective)

Course Objectives

1. To enable the students to use statistical tools in finance, industries, population studies and health sciences.
2. To acquire knowledge about sampling methods for surveys.

Course Outcomes (CO)

Upon successful completion of this course, the student will be able to:

CO1. Understand the Price and Quantity Index numbers and their different measures, understand the applicability of cost-of-living Index number.

CO2. Know the components and Need for Time series, understand the different methods of studying trend and Seasonal Index.

CO3. Study the concept of vital statistics, sources of data, different measures of Fertility and Mortality, Understand the Growth rates- GRR and NRR and their interpretations.

CO4. Know the concept of Population, Sample, Sampling unit, sampling design, sampling frame, sampling scheme, need for sampling, apply the different sampling methods for designing and selecting a sample from a population, explain sampling and non-sampling errors.

CO5. Describe the philosophy of statistical quality control tools as well as their usefulness in industry and hence develop quality control tools in each situation.

Pedagogy

The course is taught using traditional chalk and talk method using problem solving through examples and exercises. Students are encouraged to use resources available on open sources.

Contents

Unit 1: Economic Statistics **12 Hours**

Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers. Consumer price index number: construction of consumer price index numbers. Applications of consumer price index numbers

Time Series Analysis: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear). Measurement of seasonal variations by method of ratio to trend.

Unit 2: Vital Statistics **10 Hours**

Sources of demographic data, errors in data.

Measurement of mortality: crude death rate, specific death rates, and standardized death rates, infant mortality rate, maternal mortality rate, neo natal mortality rates, merits and demerits and comparisons of various mortality rates.

Measurement of Fertility and Reproduction: Fecundity, fertility, measurement of fertility, crude birth rate, general fertility rate, age specific fertility rate and total fertility rates, merits and demerits of each measure of fertility, comparative study of these measures of fertility, Growth rates: Gross reproduction rate and Net reproduction rates.

Unit 3: Sampling Theory **10 Hours**

Population and Sample. Need for sampling, Complete Enumeration versus Sample Surveys, Merits and Demerits, Non – Probability and Probability Sampling, Need and illustrations. Use of random numbers, Principal steps in sample survey. Requisites of a good questionnaire. Pilot surveys, Sampling and non – sampling errors, Description of SRS, simple random sampling with and without replacement procedures, Merits and demerits of Simple random sampling.

Need for stratification, stratifying factors, Merits and demerits of stratified random sampling. Systematic random sampling procedure of obtaining sample, Merits and demerits of systematic random sampling.

Unit 4: Statistical Quality Control **10 Hours**

Concept of quality and its management

Causes of variations in quality: chance and assignable. General theory of control charts, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts.

Acceptance Sampling Plans (Product control): Basic terminologies: AQL, LTPD, AOQ, AOQL, ASN, OC curve, producer's risk, and consumer's risk. Single sampling plan, double sampling plan.

References

1. J. Medhi (1992) Statistical Methods. New Age International (P) Ltd. New Delhi.
2. M.N. Das (1993) Statistical Methods and Concepts. Wiley Eastern Ltd.
3. Irwin Miller, John E Freund and Richard A Johnson (1992) Probability and Statistics for Engineers. Prentice Hall of India New Delhi.
4. D.C. Montgomery (1996) Introduction to Statistical Quality Control.
5. Cochran, W G. (1984) Sampling Techniques, Wiley Eastern, New Delhi.
6. Mukhopadhaya P (1998) Theory and Methods of Survey Sampling. Prentice Hall of India.
7. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied
8. Kendall M.G. (1976): Time Series, Charles Griffin.
9. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.

4. Biostatistics (Open Elective)

Course Objectives

1. To enable the students to identify the variables of biological studies and explore the tools of classification and presentation.
2. To study the probability notion, models and their applications in the study of biological phenomenon.
3. To acquire knowledge on sampling distribution and testing of hypotheses.

Course Learning Outcomes

After studying the course, the student will be able to apply statistical tools and techniques in data analysis of biological sciences.

Pedagogy

The course is taught using traditional chalk and talk method using problem solving through examples and exercises. Students are encouraged to use resources available on open sources.

Contents

Unit 1: Introduction to Bio-Statistics **10 hours**

Definition and scope of Statistics. Scales of Measurement: nominal, ordinal, interval and ratio.

Collection, classification and tabulation of data, construction of frequency table for grouped and ungrouped data, graphical representation of data by Histogram, Polygon, Ogive curves and Pie diagram.

Unit 2: Descriptive Statistics **12 hours**

Measures of Central Tendency: Arithmetic mean, Median and Mode- definition, properties, merits and limitations. Measures of Dispersion: Range, Standard deviation and Coefficient of Variation.

Correlation and Regression Analysis: Relation between two variables, definition of correlation, types of correlation, Scatter diagram, Karl-Pearson's coefficient of linear correlation and its properties, Spearman's Rank Correlation coefficient. Regression- Simple linear regression, fitting of regression equations by method of Least Squares, linear regression coefficients and their properties.

Unit 3: Probability and Distributions **10 Hours**

Probability: Random experiment, sample space, events-mutually exclusive and exhaustive events. Classical, statistical and axiomatic definitions of probability, addition and multiplication theorems, Bayes' theorem (only statements).

Discrete and continuous random variables, probability mass and density functions, distribution functions, expectation of a random variable.

Standard univariate distributions: Binomial, Poisson and Normal distributions (Elementary properties and applications only).

Unit 4: Sampling Distributions and Statistical Inference **10 hours**

Concepts of random sample and statistic, distribution of sample mean from a normal population, Chi-square, t and F distributions (No derivations) and their applications. Estimation of population mean, population standard deviation and population proportion from the sample counter parts.

Statistical Hypothesis – null and alternative hypothesis, simple and composite hypothesis. Type I and Type II errors, size, level of significance, power test, critical region, P-value and its interpretation. Test for single mean, equality of two means, single variance, equality of two variances for normal Populations, Test for proportions.

References

1. Dutta, N. K. (2004), Fundamentals of Biostatistics, Kanishka Publishers.
2. Gurumani N. (2005), An Introduction to Biostatistics, MJP Publishers.
3. Daniel, W. W. (2007), Biostatistics - A Foundation for Analysis in the Health Sciences, Wiley
4. Rao, K. V. (2007), Biostatistics - A Manual of Statistical Methods for use in Health Nutrition And Anthropology
5. Pagano, M. and Gauvreau, K. (2007), Principles of Biostatistics.
6. Rosner Bernard(2010), Fundamentals of Biostatistics, 6th Edition, Duxbury.

1. Population Studies

Course Objectives

1. To enable the students to identify appropriate sources of data, perform basic demographic analysis using various techniques and ensure their comparability across populations.

2. To acquire knowledge about the construction of life table and its applications in demographic analysis.

Course Outcomes (CO)

Upon successful completion of this course the student will be able to

CO1. Study the concepts of Vital Statistics, sources of data, different measures of Fertility, Mortality and migration.

CO2. Understand the Growth rates- GRR and NRR and their interpretations.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Contents

UNIT-1: Introduction and Sources of Population Data **14 hours**

History, definition, nature and scope of population Studies. Sources of population data – salient features of Census, Civil Registration System, National Sample Surveys, Demographic Surveys, relative merits and demerits of these sources. Coverage and content errors. Use of balancing equations, Chandrasekar-Deming formula to check completeness of vital registration data, use of Whipple's, Myer's and UN indices.

UNIT-2 : Fertility, Mortality **14 hours**

Basic concepts and terms used in the study of fertility. Measures of fertility- Crude Birth Rate (CBR), General Fertility Rate (GFR), Age Specific Fertility Rate (ASFR), Total Fertility Rate (TFR), Birth order statistics, Child Women ratio. Measures of reproduction- Gross Reproduction Rate (GRR)and Net Reproduction rate(NRR). Measurement of population growth rate- simple growth rate and compound growth rate.

Basic concepts and terms used in the study of mortality. Measures of mortality- Crude Death Rate (CDR), Age Specific Death Rate (ASDR), Direct and Indirect Standardized Death rates, Infant Mortality Rate (IMR), Under-five mortality Rate, Neo-natal mortality rate, Post-natal mortality rate; Maternal Mortality Rate (MMR).

UNIT-3: Life tables and Population change **14 hours**

Life tables: Components of a life table, force of mortality and expectation of life table, types of life tables. Construction of life tables using Reed-Merrell's method, Greville's method. Uses of life tables.

Basic concepts and definition of population change, migration. Types of migration- internal and international, factors affecting migration. Rates and ratios of Migration-Indirect measures of net-internal migration, national growth rate method, residual method, push-pull factors Population estimates and projections.

References

1. Barclay, G, W(1968). Techniques of Population Analysis, John Wiley and Sons, Incs. New York/London.
2. Keyfitz, H (1968). Introduction to the Mathematics of Population. Addison-Wesley Publishing Co.
3. Pathak, K.B and Ram, F (1991).Techniques of Demographic Analysis, Himalaya Publishing House.
4. Ramakumar. R (1986). Technical Demography, Wiley Eastern Ltd.
5. Srinivasan. K (1998). Basic Demographic Techniques and Applications, Sage Publication, New Delhi.
6. Wunsch G.J. & M.G. Tarmota(1978). Introduction to Demographic Analysis, Plenum Press, N.Y.

2. Survival Models (OE)

Course Objectives

1. Enable the students to construct and interpret life tables.
2. To understand the concepts of Survival analysis.
3. To study the design of clinical trials and their analysis.

Course Outcomes:

By the end of this course, the student should be able to:

CO1.Explain Life Tables, types of life tables, its functions, construction.

CO2. Describe multiple decrement life tables and their construction.

CO3. Know survival models, concepts of survival analysis, notion of ageing.

CO4. Explain key concepts in the design of clinical trials, phases, types, clinical trial protocol, analysis.

Content

Unit-1: Life Tables **14 hours**

Basic definition and notations, Types of life tables, inter – relationships between life table functions, Properties of life table functions. Construction of life tables using Reed – merrel and Greville's Method. Competing causes of failure/death, Multiple decrement life tables and their construction (with examples).

Unit-2: Survival Concepts **14 hours**

Life distributions, survival functions, failure rate, Integrated hazard function, residual life time, mean residual life time. Notion of aging: IFR, IFRA, DMRL, NBU, NBUE classes of life distributions and their dual classes. Common Life Distributions: binomial, Poisson, exponential, Weibull, gamma, Pareto and log-normal distributions.

Unit-3: Clinical Trials **14 hours**

Basics of Clinical Trials: Who can be in clinical trials? need clinical trials, Brief History of Clinical Trials, Common Terms in clinical Trials: Clinical Research, Healthy Volunteer, Inclusion/Exclusion Criteria, Informed Consent, Patient Volunteer, Phases of Clinical Trials, Placebo, Protocol, Principal Investigator, Randomization, Single- or Double-Blind, Studies, Types of Clinical Trials. - Diagnostic trials, Natural history studies, Prevention trials, Quality of life trials, Screening trials, Treatment trials, therapeutic trials and prophylactic trials. Observational studies – Cross sectional studies, prospective studies, retrospective studies, randomized control studies. Clinical Trial Protocol and its components. Type of analyses: ITT,

mITT and PP. Odds ratio, Relative risk, Sensitivity, specificity, false negative and false positive rates. Receiver operating characteristic(ROC) curve.

References

1. Deshpande, J V and Purohit, Sudha (2005). Life Time Data: Statistical Models and Methods. World Scientific.
2. Friedman, Furberg, and DeMets. (2010). Fundamentals of Clinical Trials (4th Edition). Springer, Free text available online at http://dx.doi.org/10.1007/978-1-4419-1586-3
3. Lawrence MF, Curt DF, David LD (2010), Fundamentals of clinical trials.
4. R. Ramkumar (1986), Technical Demography, Wiley Eastern, New Delhi.
5. Shryock, Henry S, Jacob S, Siegel and Associates (1964). Methods and materials of demography (condensed edition), Academic press, London.

3. Basics of Operations Research(OE)

Course Objectives

1. Students get knowledge about the scope and application of Operations Research(OR) in business and industry.
2. Exposes the students to various OR tools and models.
3. To get knowledge about various decision making through OR models.

Course Outcomes

Students will be able to

CO1- Generate mathematical models of business environment.

CO2-Analyze the business situations.

CO3-Use different solution procedures through OR models.

Pedagogy

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.
2. Students are encouraged to use resources available on open sources.

Contents

Unit-1: Introduction to Operations Research(OR) 14 hours

Origin and growth of OR, importance of OR in managerial decision making, scope and applications of OR, models and modelling in OR. Linear programming problems(LPP): Formulation of the problem, feasible & infeasible, basic feasible solution, optimal, unbounded and multiple optimal solutions of LPP, solution by graphical method. Slack, Surplus and Artificial variables. Duality in LPP, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality.

Unit-2: Allocation Problems 14 hours

Transportation problems: Formulation, methods of finding initial solution (Northwest Corner Rule, Least Cost Method and Vogel's Approximation Method), unbalanced transportation problems, maximization transportation problem.

Assignment problems: Formulation, methods of solution, Hungarian method, multiple optimal solutions, unbalanced problems, maximization problems.

Unit-3: Decision theory **14 hours**

Game theory: Basic concepts. Two – Person Zero Sum Game. Pure and Mixed Strategies. Maximin – Minimax principle, Games with and without saddle points. Principle of dominance.

Concepts of decision-making, decision-making environments, Decision making under uncertainty - Decision making under risk, decision tree analysis. Case discussion.

Concepts of network analysis, project network models, Critical Path Method, PERT.

References

1. Hillier, F S, et al. Introduction to Operations Research (9/e). Tata McGraw Hill, 2011.
2. Ravindran, A and Don T Phillips. Operations Research: Principles and Practice. John Wiley & Sons, 1987.
3. Sharma, J K. Operations Research: Theory and Applications (5/e). New Delhi: Laxmi Publications, 2013.
4. Taha, Hamdy A. Operations Research: An Introduction (9/e). Prentice Hall, 2010.
5. Vohra, N D. Quantitative Techniques for Management. Tata McGraw Hill Education, 2015.
6. Kanti Swarup, Gupta, P.K. and Man Mohan: Operations Research, Sultan Chand & Sons, New Delhi.
7. Kapoor, V.K: Operations Research, Sultan Chand & Sons, New Delhi.
8. Kapoor, V.K.: Operations Research Problems & Solutions, Sultan Chand & Sons, New Delhi.

4. Quantitative Analysis Techniques(OE)

Course Objectives

To enable the students to acquire the knowledge about

1. The concepts of correlation and regression analysis.
2. The concepts of linear programming problem and its applications.
3. The students will learn the tools of data mining.

Course Outcomes

Students will be able to

CO1. Carryout correlation and regression analysis.

CO2. Formulate and solve linear programming problems.

CO3. Use data mining tools.

Pedagogy

The course is taught using traditional chalk and talk method using problem solving through examples and exercises. Students are encouraged to use resources available on open sources.

UNIT- 1: Correlation and regression analysis **14 hours**

Correlation- Definition, Types - Simple, multiple, partial. Causation - Spurious, positive, negative, perfect and no correlation, explanation with examples. Importance of correlation analysis. Measurement of correlation- scatter diagram, Karl Pearson's coefficient of correlation, Properties of coefficient of correlation, interpretation. Spearman's coefficient of rank correlation – with and without ties, interpretation. Coefficient of determination and its interpretation.

Regression- Definition, regression lines/equations of X on Y and Y on X. Properties of regression coefficients and regression lines/equations. Principle of least squares and fitting of linear, quadratic and exponential curves. Uses of regression analysis. Comparison between correlation and regression.

UNIT-2: Linear programming problem(LPP) **18 hours**

Definition and scope of Operations Research (OR). Modelling and solution. Linear Programming Problem (L.P.P): Definition, Standard forms. Formulation of LPP. Basic Solutions, degenerate and non-degenerate solutions. Graphical method of solving LPP. Criteria for unbounded, Multiple and infeasible solutions.

Transportation problem: Mathematical formulation. Existence of feasible solution. Finding initial basic feasible solution: North West Corner Rule, matrix minima method and Vogel’s method. Unbalanced transportation problem.

Assignment Problem: Mathematical Formulation and Hungarian algorithm. Unbalanced assignment problem.

UNIT-3: Data Mining **10 hours**

Motivations and importance of Knowledge Discovery in Databases (KDD) process - search, induction, querying, approximation and compression. Kinds of data considered for data mining, basic data mining tasks, data mining issues, Data Mining models - predictive and descriptive, interconnections between Statistics and Data Mining. Artificial Intelligence and Machine Learning. Applications of data mining.

References

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I, 8th Ed., The World Press, Kolkata.
2. Ross, S.M. (2014). Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
3. Kanthi Swaroop, Manmohan and P. K. Gupta (2013). Operation Research, Sultan Chand New Delhi.
4. Mustafi, C. K. (2006). Operations Research Methods and Practice, 3/e. New Age Publication.
5. Narag. A. S. (1970). Linear Programming and Decision Making. Sultan Chand and Co.
6. Sharma, J K.(2013). Operations Research: Theory and Applications (5/e). New Delhi: Laxmi Publications.
7. Jiawei Han, Micheline Kamber (2002). Data mining concepts and Techniques, Morgan Kaufman Publishers, USA.
8. Trevor Hastie, Robert Tibshirani and Jerome Friedman (2001). The elements of Statistical learning: Data Mining, Inference and Prediction, Springer, New York.
9. Rajan Chattamvelli (2009). Data mining methods, Narosa Publishing House.