MODEL CURRICULUM FOR THE UNDER-GRADUATE PROGRAMS IN UNIVERSITIES AND COLLEGES OF KARNATAKA

SUBJECT: STATISTICS

SUBMITTED TO

Vice Chairman
KARNATAKA STATE HIGHER EDUCATION COUNCIL
30, Prasanna Kumar Block, Bengaluru Central University Campus, Y Ramachandra Road, Gandhinagar, Bengaluru, Karnataka - 560009

Index

Serial Number	Content
1.	Bachelor of Science etc. With Statistics as Major with practicals and any other subject as minor
2.	Bachelor of Science etc. With Statistics as Minor with practicals and any other subject as major
3.	Bachelor of Science with Statistics as one of the majorswith practicals with other subject asanother major in 3rd year
4.	List of Open electives (OE) curriculum
5.	Bachelor of Arts with Applied Statistics as Minor without practicals & other course asMajor without practicals And Bachelor of Arts with Applied Statistics as Minor without practicals & other course as Major with practicals
6.	List of Open electives (OE) curriculum

The subject expert committee consists of

1. Prof. Parameshwar V Pandit,(Chairperson)
   Professor and Chairperson, Department of Statistics
   Bangalore University, Bengaluru

2. Dr. B S Biradar
   Professor and Chairperson, Department of Statistics
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10. Dr. S R Gani
    Department of Statistics
    Karnataka Arts College, Dharwad

11. Dr. Tejaswini B Yakkundimath (Member Convener)
    Special Officer Karnataka State Higher Education council

Name of the Degree Program: B.Sc.

Discipline Core: Statistics

Program Outcomes

By the end of the program the students will be able to:

1. Acquire fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
4. Understand procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
6. Have a knowledge regarding use of data analytics tools like Excel and R-programming.
7. Developed ability to critically assess a standard report having graphics, probability statements.
8. Analyze, interpret the data and hence help policy makers to take a proper decision.
9. Recognize the importance of statistical modelling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various statistical tools.
10. Demonstrate relevant generic skills and global competencies such as
    (i) Problem-solving skills that are required to solve different types of Statistics related problems with well-defined solutions, and tackle open-ended problems, that belong

to the disciplinary-area boundaries;

(ii) Investigative skills, including skills of independent thinking of Statistics-related issues and problems;

(iii)Communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature;

(iv)Analytical skills involving paying attention to details and ability to construct logical Arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi)Personal skills such as the ability to work both independently and in a group.

11. Undertake research projects by using research skills- preparation of questionnaire, conducting national sample survey, research projects using sample survey, sampling techniques.

12. Understand and apply principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.

Assessment

Weightage for assessments (in percentage)

Type of Course	**Formative Assessment / IA**	**Summative Assessment**
Theory	**40**	**60**
Practical	**25**	**25 (Practical record))**
Projects		
Experiential Learning (Internships, etc.)		

List of Open Elective (OE) for first two semesters

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

Curriculum Structure for the Undergraduate Degree Program
B.Sc.

Total Credits for the Program: 176 **Discipline/Subject: Statistics(Major)**

Program Articulation Matrix
This matrix lists only the core courses. Core courses are essential to earn the degree in thatdiscipline/subject. They include courses such as theory, laboratory, project, internships etc.
Elective courses may be listed separately

Semester	Title /Name of the course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy	Assessment
1	**Descriptive Statistics**	PO1,PO2,PO8	Mathematics of 12th level	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.	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
1	**Practical**	PO5, PO6	Mathematics of 12th level	The course is taught using Excel software and/or manually to carry out descriptive statistical analysis.	Assessment of learning through experiments
2	**Probability and Distributions**	PO7,PO9,PO10	Mathematics of 12th level	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	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
2	**Practical**	PO5,PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing

better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOC
$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

Course Pre-requisite(s): **II PUC with Mathematics**

Course Outcomes (COs)

At the end of the course the student should be able to:

1. Acquire knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.
2. Get knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.
3. Perceive the knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.
4. Learn different of types of data reflecting independence and association between two or more attributes.
5. Develop ability to critically assess a standard report having graphics, probability statements.
6. Conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem,
7. Get knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments,
8. Learn knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal distributions.
9. Acquire knowledge on R-programming in the descriptive statistics and probability models.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.	X	X			X	X						
2.Knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.			X	X	X	X				X	X	
3. Knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.				X	X	X		X		X	X	
4.Knowledge of types of data reflecting independence and association between two or more attributes				X	X	X				X		X
5. Develop ability to critically assess a standard report having graphics, probability statements.					X	X	X		X			
6. Knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem.					X	X			X	X		
7. Knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments.					X	X			X	X		
8. Knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal, distributions.					X	X			X	X		
9. Knowledge on R-programming in the descriptive statistics and probability models.					X	X			X	X		

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. 'X' in the intersection cell indicates that particular course outcome addresses that particular program outcome.

BSc Semester 1

Course Title: Descriptive Statistics	
Total Contact Hours: 60	Course Credits:04
Formative Assessment Marks:40	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Title of the Course: Descriptive Statistics

Number of Theory Credits	**Number of lecture hours/semester**	**Number of practical Credits**	**Number of practical hours/semester**
4	**60**	**2**	**60**

Content of Theory Course 1	
Unit – 1 : Introduction to Statistics	
Statistics: Definition and scope. Concepts of statistical population and sample (SRS, Stratified, Systematic and Cluster sampling methods Definitions only). Data: quantitative and qualitative, cross sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays. (Ref. 4)	
Unit – 2: Univariate Data Analysis	
Measures of Central Tendency: Mean, weighted mean, trimmed mean, Median, Mode, Geometric and harmonic means, properties, merits and limitations, relation between these measures. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures. Gini's Coefficient, Lorenz Curve. Moments, Skewness and Kurtosis. Quantiles and measures based on them. Box Plot. Outliers. Chebyshev's inequality, normal data sets. (Ref.10).	
Unit – 3: Bivariate Data Analysis	
Bivariate Data, Scatter plot, Correlation, Karl Pearson's correlation coefficient, Rank correlation – Spearman's and Kendall's measures. Concept of errors, Principle of least squares, fitting of polynomial and exponential curves. Simple linear regression and its properties. Fitting of linear regression line and coefficient of determination. (Ref. 10)	
Unit –4: Multivariate Data Analysis	
Analysis of Categorical Data: Contingency table, independence and association of attributes, measures of association - odds ratio, Pearson's and Yule's measure, Multivariate Frequencies, Multivariate Data Visualization, mean vector and dispersion matrix, Multiple linear regression, multiple and partial correlation coefficients. Residual error variance. (Ref. 7)	

References

1. Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996). The New Statistical Analysis of Data, Springer
3. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
4. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7th Edition.
5. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
6. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
7. Joao Mendes Moreira, Andre C P L F de Carvalho, Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
8. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
9. Medhi, J. (2005), Statistical Methods, New Age International.
10. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
11. Tukey, J.W. (1977), Exploratory Data Analysis, Addison-Wesley Publishing Co.

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: Total 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

Date:14-09-2021 Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 1

(Computing all the practicals manually and using Excel)

1. Presentation of data by frequency tables, diagrams and graphs, stem and leaf, partition values.
2. Arithmetic Mean (AM), geometric mean, harmonic mean, weighted AM, trimmed mean, corrected mean.
3. Mode, median, partition values.
4. Absolute and relative measures of dispersion, Box plots.
5. Problems on moments, skewness and kurtosis.
6. Fitting of curves by least squares method.
7. Product moment correlation coefficient and rank correlation.
8. Regression of two variables.
9. Multivariate Descriptive statistics, mean Vector, dispersion matrix correlation matrix, Partial and Multiple correlation.
10. Problems on Association of attributes.

B.Sc.
Semester 2

Course Title: Probability and Distributions	
Total Contact Hours: 60	Course Credits:04
Formative Assessment Marks: 40	Duration of ESA/Exam: 2hours
Model Syllabus Authors: State level modelcurriculum setting committee members-Statistics	Summative Assessment Marks:60

Course Pre-requisite(s): II PUC with Mathematics

Title of the Course: Probability and Distributions

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Content of Theory Course 2	
Unit –1 : Probability	
Random experiment, sample space and events, algebra of events. Definitions of Probability- Classical, statistical, subjective and axiomatic approaches – illustrations and applications, Addition rule, Conditional probability, independence of events and multiplication rule, Total probability rule, Bayes theorem- applications.	
Unit –2:Random Variables And Mathematical Expectation-(One Dimension)	
Definitions of discrete and continuous random variables, Distribution function, probability mass and density functions – properties and illustrations, Expectation of a random variable and rules of expectation and related results, Moments and moment generating function – properties and uses.	
Unit –3 : Standard Distributions	
Bernoulli, Binomial, Poisson, distributions– mean, variance, moments and m. g. f. recursive relations for probabilities and moments of Binomial and Poisson distributions, Normal distribution and its properties.	

Unit –4: Data Analysis Using R	**14 Hrs**
Introduction to R: Installation, command line environment, overview of capabilities, brief mention of open source philosophy. R as a calculator: The four basic arithmetic operations. Use of parentheses nesting up to arbitrary level. The power operation. Evaluation of simple expressions. Quotient and remainder operations for integers. Standard functions, e.g., sin, cos, exp, log. The different types of numbers in R: Division by zero leading to Inf or -Inf. NaN. NA. No need to go into details. Variables. Creating a vector using c(), seq() and colon operator. How functions map over vectors. Functions to summarize a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property). R as a graphing calculator: Introduction to plotting. Plot(), lines(), abline(). No details about the graphics parameters except colour and line width. Barplot, Pie chart and Histogram. Box plot. Scatter plot and simple linear regression using lm(y~x). Problems on discrete and continuous probability distributions.	

References

1. Dudewitz. E.J. and Mishra. S. N. (1998), Modern Mathematical Statistics. John Wiley.
2. Goon A.M., Gupta M.K., Das Gupta .B. (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Gupta. S.C and V.K. Kapoor (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Co, 12th Edition.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007), Introduction to the Theory of Statistics, 3rd Edition. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Ross, S. (2002), A First Course in Probability, Prentice Hall.
7. Sudha G. Purohit, Sharad D. Gore, Shailaja R Deshmukh,(2009), Statistics Using R, Narosa Publishing House.
8. R for beginners by Emmanuel Paradis (freely available at **https://cran.r-project.org/doc/contrib/Paradisrdebuts_en.pdf**)

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 2: List of Experiments to be conducted

(Computing all the practicals manually and using Excel/R)

1. Two exercise on Descriptive statistics (Presentations, Summarizations, correlations, regression and Graphs using R)
2. Computing probability: using addition and multiplication theorems.
3. Conditional probability and Bayes' theorem.
4. Problems on pmf, expectation, variance, quantiles, skewness, kurtosis (Discrete Case).
5. Problems on pdf, expectation, variance, quantiles, skewness, kurtosis (Continuous case).
6. Problems on discrete probability distributions(Binomial and Poisson)
7. Problems on Normal probability distributions
8. Computation of moments and Moment generating functions (Discrete and Continuous Case).
9. Fitting of distributions Binomial, Poisson, Normal distributions.
10. Generation of random samples. (Binomial, Poisson, Normal)

Model Program Structure for the Under-Graduate Programs in Universities and Colleges of Karnataka

Bachelor of Science

With Statistics as Minor with practicals and any other subject as major

Name of the Degree Program: B.Sc. **Discipline Core: Statistics(Minor)**

Total Credits for the Program: 136(till 6th semesters)

Program Outcomes

By the end of the program the students will be able to:

1. Acquire fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
4. Understand procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
6. Have a knowledge regarding use of data analytics tools like Excel and R-programming.
7. Developed ability to critically assess a standard report having graphics, probability statements.
8. Analyze, interpret the data and hence help policy makers to take a proper decision.
9. Recognize the importance of statistical modelling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various statistical tools.
10. Demonstrate relevant generic skills and global competencies such as

    (i) Problem-solving skills that are required to solve different types of Statistics related

problems with well-defined solutions, and tackle open-ended problems, that belong to the disciplinary-area boundaries;

(ii) Investigative skills, including skills of independent thinking of Statistics-related issues and problems;

(iii)Communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature;

(iv)Analytical skills involving paying attention to details and ability to construct logical Arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi)Personal skills such as the ability to work both independently and in a group.

11. Undertake research projects by using research skills- preparation of questionnaire, conducting national sample survey, research projects using sample survey, sampling techniques.

12. Understand and apply principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.

Assessment

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	**40**	**60**
Practical	**25**	**25**
Projects	**40**	**60**
Experiential Learning (Internships, etc.)	**40**	**60**

Summary of Discipline Specific Courses (DSC)			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	DSC B1	Descriptive Statistics	4
		Practicals based on DSC B1	2
II	DSC B2	Probability and Distributions	4
		Practicals based on DSC B2	2

List of Open Elective (OE) for first two semesters

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

Curriculum Structure for the Undergraduate Degree Program

B.Sc.

Total Credits for the Program: 136 **Starting year of implementation: 2021-22**
Name of the Degree Program : B. Sc. **Discipline/Subject: Statistics(minor)**

Program Articulation Matrix:
This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Sem ester	Title /Name of the course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment$
1	**Descriptive Statistics**	PO1,PO2,PO8	Mathematics of 12^{th} level	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.	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
1	**Practical**	PO5, PO6	Mathematics of 12^{th} level	The course is taught using Excel software and/or manually to carry out descriptive statistical analysis.	Assessment of learning through experiments
2	**Probability and Distributions**	PO7,PO9,PO10	Mathematics of 12^{th} level	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	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
2	**Practical**	PO5,PO6	Mathematics of 12^{th} level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOC

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

Course Pre-requisite(s): **II PUC with Mathematics**

Course Outcomes (COs)

At the end of the course the student should be able to

1. Acquire knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.
2. Get knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.
3. Perceive the knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.
4. Learn different of types of data reflecting independence and association between two or more attributes.
5. Develop ability to critically assess a standard report having graphics, probability statements.
6. Conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem,
7. Get knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments,
8. Learn knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal distributions.
9. Acquire knowledge on R-programming in the descriptive statistics and probability models.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.	X	X			X	X						
2.Knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.			X	X	X	X				X	X	
3. Knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.				X	X	X		X		X	X	
4.Knowledge of types of data reflecting independence and association between two or more attributes				X	X	X				X		X
5. Develop ability to critically assess a standard report having graphics, probability statements.					X	X	X		X			
6. Knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem.					X	X			X	X		
7. Knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments.					X	X			X	X		
8. Knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal, distributions.					X	X			X	X		
9. Knowledge on R-programming in the descriptive statistics and probability models.					X	X			X	X		

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. 'X' in the intersection cell indicates that particular course outcome addresses that particular program outcome.

BSc Semester 1

Course Title: B.Sc	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks:40	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Title of the Course: Descriptive Statistics

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	**56**	**2**	**52**

Content of Theory Course 1	**56 Hrs**
Unit – 1 : Introduction to Statistics	**13 Hrs**
Statistics: Definition and scope. Concepts of statistical population and sample (SRS, Stratified, Systematic and Cluster sampling methods Definitions only). Data: quantitative and qualitative, cross sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays. (Ref. 4)	
Unit – 2: Univariate Data Analysis	**18 Hrs**
Measures of Central Tendency: Mean, weighted mean, trimmed mean, Median, Mode, Geometric and harmonic means, properties, merits and limitations, relation between these measures. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures. Gini's Coefficient, Lorenz Curve. Moments, Skewness and Kurtosis. Quantiles and measures based on them. Box Plot. Outliers. Chebyshev's inequality, normal data sets. (Ref.10).	
Unit – 3: Bivariate Data Analysis	**15 Hrs**
Bivariate Data, Scatter plot, Correlation, Karl Pearson's correlation coefficient, Rank correlation – Spearman's and Kendall's measures. Concept of errors, Principle of least squares, fitting of polynomial and exponential curves. Simple linear regression and its properties. Fitting of linear regression line and coefficient of determination. (Ref. 10)	
Unit –4: Multivariate Data Analysis	**10 Hrs**
Analysis of Categorical Data: Contingency table, independence and association of attributes, measures of association - odds ratio, Pearson's and Yule's measure, Multivariate Frequencies, Multivariate Data Visualization, mean vector and dispersion matrix, Multiple linear regression, multiple and partial correlation coefficients. Residual error variance. (Ref. 7)	

References

1. Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996). The New Statistical Analysis of Data, Springer
3. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
4. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7th Edition.
5. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
6. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
7. Joao Mendes Moreira, Andre C P L F de Carvalho, Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
8. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
9. Medhi, J. (2005), Statistical Methods, New Age International.
10. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
11. Tukey, J.W. (1977), Exploratory Data Analysis, Addison-Wesley Publishing Co.

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: Total 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 1

(Computing all the practicals manually and using Excel)

1. Presentation of data by frequency tables, diagrams and graphs, stem and leaf, partition values.
2. Arithmetic Mean (AM), geometric mean, harmonic mean, weighted AM, trimmed mean, corrected mean.
3. Mode, median, partition values.
4. Absolute and relative measures of dispersion, Box plots.
5. Problems on moments, skewness and kurtosis.
6. Fitting of curves by least squares method.
7. Product moment correlation coefficient and rank correlation.
8. Regression of two variables.
9. Multivariate Descriptive statistics, mean Vector, dispersion matrix correlation matrix, Partial and Multiple correlation.
10. Problems on Association of attributes.

B.Sc.
Semester 2

Course Title: B.Sc.	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level model curriculum setting committee members-Statistics	Summative Assessment Marks: 70

Course Pre-requisite(s): II PUC with Mathematics

Title of the Course: Probability and Distributions

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Content of Theory Course 2	56Hrs
Unit –1 : Probability	**15 Hrs**
Random experiment, sample space and events, algebra of events. Definitions of Probability- Classical, statistical, subjective and axiomatic approaches – illustrations and applications, Addition rule, Conditional probability, independence of events and multiplication rule, Total probability rule, Bayes theorem- applications.	
Unit –2:Random Variables And Mathematical Expectation-(One Dimension)	**14 Hrs**
Definitions of discrete and continuous random variables, Distribution function, probability mass and density functions – properties and illustrations, Expectation of a random variable and rules of expectation and related results, Moments and moment generating function – properties and uses.	
Unit –3 : Standard Distributions	**13 Hrs**
Bernoulli, Binomial, Poisson, distributions– mean, variance, moments and m. g. f. recursive relations for probabilities and moments of Binomial and Poisson distributions, Normal distribution and its properties.	

Unit –4: Data Analysis Using R	**14 Hrs**
Introduction to R: Installation, command line environment, overview of capabilities, brief mention of open source philosophy. R as a calculator: The four basic arithmetic operations. Use of parentheses nesting up to arbitrary level. The power operation. Evaluation of simple expressions. Quotient and remainder operations for integers. Standard functions, e.g., sin, cos, exp, log. The different types of numbers in R: Division by zero leading to Inf or -Inf. NaN. NA. No need to go into details. Variables. Creating a vector using c(), seq() and colon operator. How functions map over vectors. Functions to summarize a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property). R as a graphing calculator: Introduction to plotting. Plot(), lines(), abline(). No details about the graphics parameters except colour and line width. Barplot, Pie chart and Histogram. Box plot. Scatter plot and simple linear regression using lm(y~x). Problems on discrete and continuous probability distributions.	

References

1. Dudewitz. E.J. and Mishra. S. N. (1998), Modern Mathematical Statistics. John Wiley.
2. Goon A.M., Gupta M.K., Das Gupta .B. (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Gupta. S.C and V.K. Kapoor (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Co, 12^{th} Edition.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007), Introduction to the Theory of Statistics, 3rd Edition. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Ross, S. (2002), A First Course in Probability, Prentice Hall.
7. Sudha G. Purohit, Sharad D. Gore, Shailaja R Deshmukh,(2009), Statistics Using R, Narosa Publishing House.
8. R for beginners by Emmanuel Paradis (freely available at **https://cran.r-project.org/doc/contrib/Paradisrdebuts_en.pdf**)

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 2: List of Experiments to be conducted

(Computing all the practicals manually and using Excel/R)

1. Two exercise on Descriptive statistics (Presentations, Summarizations, correlations, regression and Graphs using R)
2. Computing probability: using addition and multiplication theorems.
3. Conditional probability and Bayes' theorem.
4. Problems on pmf, expectation, variance, quantiles, skewness, kurtosis (Discrete Case).
5. Problems on pdf, expectation, variance, quantiles, skewness, kurtosis (Continuous case).
6. Problems on discrete probability distributions(Binomial and Poisson)
7. Problems on Normal probability distributions
8. Computation of moments and Moment generating functions (Discrete and Continuous Case).
9. Fitting of distributions Binomial, Poisson, Normal distributions.
10. Generation of random samples. (Binomial, Poisson, Normal)

Model Program Structure for the Under-Graduate Programs in Universities and Colleges of Karnataka

Bachelor of Science (Basic/Hons.)

With Statistics as one of the majors with practical's with other subject asanother major in 3rd year

Name of the Degree Program: B.Sc.

Discipline Core: Statistics (Major) **Total Credits for the Program: 176(till 8th semesters)**

Starting year of implementation: 2021-22

Program Outcomes

By the end of the program the students will be able to:

1. Acquire fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics.
4. Understand procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
6. Have a knowledge regarding use of data analytics tools like Excel and R-programming.
7. Developed ability to critically assess a standard report having graphics, probability statements.
8. Analyze, interpret the data and hence help policy makers to take a proper decision.
9. Recognize the importance of statistical modelling and computing, and the role of approximation and mathematical approaches to analyze the real problems using various statistical tools.
10. Demonstrate relevant generic skills and global competencies such as

    (i) Problem-solving skills that are required to solve different types of Statistics related

problems with well-defined solutions, and tackle open-ended problems, that belong to the disciplinary-area boundaries;

(ii) Investigative skills, including skills of independent thinking of Statistics-related issues and problems;

(iii)Communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature;

(iv)Analytical skills involving paying attention to details and ability to construct logical Arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi)Personal skills such as the ability to work both independently and in a group.

11. Undertake research projects by using research skills- preparation of questionnaire, conducting national sample survey, research projects using sample survey, sampling techniques.

12. Understand and apply principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.

Assessment

Weightage for assessments (in percentage)

Type of Course	**Formative Assessment / IA**	**Summative Assessment**
Theory	**30**	**60**
Practical	**15**	**35(30+5(Practical record))**
Projects	**30**	**60**
Experiential Learning (Internships, etc.)	**40**	**60**

Summary of Discipline Specific Courses (DSC)			
Semester	**Course Code**	**Title of the Paper**	**Credits**
I	DSC A1	Descriptive Statistics	4
		Practicals based on DSC A1	**2**
II	DSC A2	Probability and Distributions	4
		Practicals based on DSC A2	2
III	DSC A3	Calculus and Probability Distributions	4
		Practicals based on DSC A3	2
IV	DSC A4	Statistical Inference-I	4
		Practicals based on DSC A4	2
V	DSC A5	Matrix Algebra and Regression Analysis	3
		Practicals based on DSC A5	2
	DSC A6	Analysis of variance and design of experiments	3
		Practicals based on DSC A6	2
VI	DSC A7	Statistical Inference-II	3
		Practicals based on DSC A7	2
VII	DSC A8	Sample Surveys and Statistics for National Development	3
		Practicals based on DSC A8	2
	DSC A9	Real Analysis	3
		Practicals based on DSC A9	2
	DSC A10	Probability Theory	4
VIII	DSC A11	Linear Algebra	4
	DSC A12	Linear models and Design of Experiments	4
IX	DSC A13	Multivariate Analysis	3
		Practicals based on DSC A13	2
	DSC A14	Distribution Theory	3
		Practicals based on DSC A14	2
	DSC A15	Decision Theory and Bayesian Inference	4
X	DSC A16	Stochastic Processes	4
	DSC A17	Time Series Analysis	4

List of Discipline Specific Electives (DSE)

- Actuarial Statistics
- Advanced Statistical Inference
- Analysis of Categorical Data
- Analysis of Clinical Trials
- Artificial Intelligence with R
- Asymptotic Theory of Statistical Inference
- Bayesian Inference
- Bio-Statistics
- Computational Statistics
- Data Analytics with R/Python
- Data Science : Multivariate Techniques with R /Python
- Data Science with R/Python
- Demography
- Extreme value Theory
- Financial Statistics
- Econometrics
- Machine Learning with R/Python
- Multivariate Techniques
- Nonparametric and Semiparametric Methods
- Operations Research
- Project Work-I
- Reliability Analysis
- Reliability and Statistical Quality Control
- Statistical Learning and Data Mining with R/Python
- Statistical Quality Control
- Stochastic Models in Finance
- Survival Analysis
- Time Series Analysis
- Sampling Theory and Applications

List of Open Elective (OE) for first two semesters

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

Curriculum Structure for the Undergraduate Degree Program

B.Sc.

Total Credits for the Program: 176 **Starting year of implementation: 2021-22**
Name of the Degree Program : B. Sc. **Discipline/Subject: Statistics(Major)**

Program Articulation Matrix:
This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Sem ester	Title /Name of the course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment$
1	**Descriptive Statistics**	PO1,PO2,PO8	Mathematics of 12th level	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.	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
1	**Practical**	PO5, PO6	Mathematics of 12th level	The course is taught using Excel software and/or manually to carry out descriptive statistical analysis.	Assessment of learning through experiments
2	**Probability and Distributions**	PO7,PO9,PO10	Mathematics of 12th level	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	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
2	**Practical**	PO5,PO6	Mathematics of 12th level	The course is taught using R programming software and/or manually to carry out descriptive statistical analysis	Assessment of learning through experiments

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course

projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOC
$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

Course Pre-requisite(s): **II PUC with Mathematics**

Course Outcomes (COs)

At the end of the course the student should be able to:

1. Acquire knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.
2. Get knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.
3. Perceive the knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.
4. Learn different of types of data reflecting independence and association between two or more attributes.
5. Develop ability to critically assess a standard report having graphics, probability statements.
6. Conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem,
7. Get knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments,
8. Learn knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal distributions.
9. Acquire knowledge on R-programming in the descriptive statistics and probability models.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Knowledge of introductory statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.	X	X			X	X						
2.Knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.			X	X	X	X				X	X	
3. Knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.				X	X	X		X		X	X	
4.Knowledge of types of data reflecting independence and association between two or more attributes				X	X	X				X		X
5. Develop ability to critically assess a standard report having graphics, probability statements.					X	X	X		X			
6. Knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach. Simultaneously, they will learn the notion of conditional probability including the concept of Bayes' Theorem.					X	X			X	X		
7. Knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments.					X	X			X	X		
8. Knowledge of important discrete and continuous distributions such as Binomial, Poisson, Normal, distributions.					X	X			X	X		
9. Knowledge on R-programming in the descriptive statistics and probability models.					X	X			X	X		

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. 'X' in the intersection cell indicates that particular course outcome addresses that particular program outcome.

BSc Semester 1

Course Title: B.Sc	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks:40	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level model curriculum setting committee members-Statistics	Summative Assessment Marks: 60

Title of the Course: Descriptive Statistics

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	**56**	**2**	**52**

Content of Theory Course 1	56 Hrs
Unit – 1 : Introduction to Statistics	**13 Hrs**
Statistics: Definition and scope. Concepts of statistical population and sample (SRS, Stratified, Systematic and Cluster sampling methods Definitions only). Data: quantitative and qualitative, cross sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays. (Ref. 4)	
Unit – 2: Univariate Data Analysis	**18 Hrs**
Measures of Central Tendency: Mean, weighted mean, trimmed mean, Median, Mode, Geometric and harmonic means, properties, merits and limitations, relation between these measures. Measures of Dispersion: Range, Quartile deviation, Mean deviation, Standard deviation and their relative measures. Gini's Coefficient, Lorenz Curve. Moments, Skewness and Kurtosis. Quantiles and measures based on them. Box Plot. Outliers. Chebyshev's inequality, normal data sets. (Ref.10).	
Unit – 3: Bivariate Data Analysis	**15 Hrs**
Bivariate Data, Scatter plot, Correlation, Karl Pearson's correlation coefficient, Rank correlation – Spearman's and Kendall's measures. Concept of errors, Principle of least squares, fitting of polynomial and exponential curves. Simple linear regression and its properties. Fitting of linear regression line and coefficient of determination. (Ref. 10)	
Unit –4: Multivariate Data Analysis	**10 Hrs**
Analysis of Categorical Data: Contingency table, independence and association of attributes, measures of association - odds ratio, Pearson's and Yule's measure, Multivariate Frequencies, Multivariate Data Visualization, mean vector and dispersion matrix, Multiple linear regression, multiple and partial correlation coefficients. Residual error variance. (Ref. 7)	

References

1. Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996). The New Statistical Analysis of Data, Springer
3. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
4. Gupta, S.C. (2018), Fundamental of Statistics, Himalaya Publishing House, 7th Edition.
5. Gupta S.C. and V.K. Kapoor (2020), Fundamental of Mathematical Statistics, Sultan Chand and Co. 12th Edition.
6. Hogg, R. V. McKean J. W. and Craig, A. T. (2012), Introduction to Mathematical Statistics, Pearson 7th Edition.
7. Joao Mendes Moreira, Andre C P L F de Carvalho, Tomas Horvath (2018), General Introduction to Data Analytics, Wiley.
8. Johnson, R.A. and Bhattacharyya, G.K. (2006), Statistics: Principles and methods. 5th Edition, John Wiley & Sons, New York.
9. Medhi, J. (2005), Statistical Methods, New Age International.
10. Ross, S.M. (2014), Introduction to Probability and Statistics for Engineers and Scientists, 5th Edition, Academic Press.
11. Tukey, J.W. (1977), Exploratory Data Analysis, Addison-Wesley Publishing Co.

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: Total 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 1

(Computing all the practicals manually and using Excel)

1. Presentation of data by frequency tables, diagrams and graphs, stem and leaf, partition values.
2. Arithmetic Mean (AM), geometric mean, harmonic mean, weighted AM, trimmed mean, corrected mean.
3. Mode, median, partition values.
4. Absolute and relative measures of dispersion, Box plots.
5. Problems on moments, skewness and kurtosis.
6. Fitting of curves by least squares method.
7. Product moment correlation coefficient and rank correlation.
8. Regression of two variables.
9. Multivariate Descriptive statistics, mean Vector, dispersion matrix correlation matrix, Partial and Multiple correlation.
10. Problems on Association of attributes.

B.Sc.
Semester 2

Course Title: B.Sc.	
Total Contact Hours: 56	Course Credits:04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level modelcurriculum setting committee members-Statistics	Summative Assessment Marks: 70

Course Pre-requisite(s): II PUC with Mathematics

Title of the Course: Probability and Distributions

Number of Theory Credits	Number of lecture hours/semester	Number of practical Credits	Number of practical hours/semester
4	56	2	52

Content of Theory Course 2	56Hrs
Unit –1 : Probability	**15 Hrs**
Random experiment, sample space and events, algebra of events. Definitions of Probability- Classical, statistical, subjective and axiomatic approaches – illustrations and applications, Addition rule, Conditional probability, independence of events and multiplication rule, Total probability rule, Bayes theorem- applications.	
Unit –2:Random Variables And Mathematical Expectation-(One Dimension)	**14 Hrs**
Definitions of discrete and continuous random variables, Distribution function, probability mass and density functions – properties and illustrations, Expectation of a random variable and rules of expectation and related results, Moments and moment generating function – properties and uses.	
Unit –3 : Standard Distributions	**13 Hrs**
Bernoulli, Binomial, Poisson, distributions– mean, variance, moments and m. g. f. recursive relations for probabilities and moments of Binomial and Poisson distributions, Normal distribution and its properties.	

Unit –4: Data Analysis Using R	**14 Hrs**
Introduction to R: Installation, command line environment, overview of capabilities, brief mention of open source philosophy. R as a calculator: The four basic arithmetic operations. Use of parentheses nesting up to arbitrary level. The power operation. Evaluation of simple expressions. Quotient and remainder operations for integers. Standard functions, e.g., sin, cos, exp, log. The different types of numbers in R: Division by zero leading to Inf or -Inf. NaN. NA. No need to go into details. Variables. Creating a vector using c(), seq() and colon operator. How functions map over vectors. Functions to summarize a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property). R as a graphing calculator: Introduction to plotting. Plot(), lines(), abline(). No details about the graphics parameters except colour and line width. Barplot, Pie chart and Histogram. Box plot. Scatter plot and simple linear regression using lm(y~x). Problems on discrete and continuous probability distributions.	

References

1. Dudewitz. E.J. and Mishra. S. N. (1998), Modern Mathematical Statistics. John Wiley.
2. Goon A.M., Gupta M.K., Das Gupta .B. (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Gupta. S.C and V.K. Kapoor (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Co, 12th Edition.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009), Probability and Statistical Inference, Seventh Edition, Pearson Education, New Delhi.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007), Introduction to the Theory of Statistics, 3rd Edition. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Ross, S. (2002), A First Course in Probability, Prentice Hall.
7. Sudha G. Purohit, Sharad D. Gore, Shailaja R Deshmukh,(2009), Statistics Using R, Narosa Publishing House.
8. R for beginners by Emmanuel Paradis (freely available at **https://cran.r-project.org/doc/contrib/Paradisrdebuts_en.pdf**)

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Practical Course 2: List of Experiments to be conducted

(Computing all the practicals manually and using Excel/R)

1. Two exercise on Descriptive statistics (Presentations, Summarizations, correlations, regression and Graphs using R)
2. Computing probability: using addition and multiplication theorems.
3. Conditional probability and Bayes' theorem.
4. Problems on pmf, expectation, variance, quantiles, skewness, kurtosis (Discrete Case).
5. Problems on pdf, expectation, variance, quantiles, skewness, kurtosis (Continuous case).
6. Problems on discrete probability distributions(Binomial and Poisson)
7. Problems on Normal probability distributions
8. Computation of moments and Moment generating functions (Discrete and Continuous Case).
9. Fitting of distributions Binomial, Poisson, Normal distributions.
10. Generation of random samples. (Binomial, Poisson, Normal)

List of Open Electives (OE)

1. **Statistical Methods**
2. **Business Statistics**
3. **Applied statistics**
4. **Biostatistics**

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 a given 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.

Model Program Structures for the Under-Graduate Programs in Universities and Colleges of Karnataka

Bachelor of Arts (Basic/Hons.)

With Applied Statistics as Minor without practicals & other course as Major without practicals

And

Bachelor of Arts (Basic/ Hons.)

With Applied Statistics as Minor without practicals & other course as Major with practicals

Name of the Degree Program: B.A

Discipline Core: Applied Statistics

Total Credits for the Program: 136(till 6th semesters)

Starting year of implementation: 2021-22

Program Outcomes

By the end of the program the students will be able to:

1. Acquire fundamental/systematic or coherent understanding of the academic field of Statistics and its different learning areas and applications.
2. Develop and demonstrate an ability to understand major concepts in various disciplines of Statistics and its applications.
3. Demonstrate the ability to use skills in Statistics and different practicing areas for formulating and tackling Statistics related problems and identifying and applying appropriate principles and methodologies to solve a wide range of problems associated with Statistics of various studies.
4. Understand procedural knowledge that creates different types of professionals related to subject area of Statistics, including professionals engaged in government/public service and private sectors.
5. Plan and execute Statistical experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate statistical software including programming languages, and report accurately the findings of the experiment/investigations.
6. Have a knowledge regarding use of data analytics tools like Excel and R-programming.
7. Develop an ability to critically assess a standard report having graphics, probability statements.
8. Analyze, interpret the data and hence help policy makers to take a proper decision.
9. Recognize the importance of statistical modelling and computing, and the role of approximation and statistical approaches to analyze the real problems of different disciplines using various statistical tools.
10. Demonstrate relevant generic skills and global competence such as

    (i) Problem-solving skills that are required to solve different types of Statistics related

problems with well-defined solutions, and tackle open-ended problems, that belong to the disciplinary-area boundaries;

(ii) Investigative skills, including skills of independent thinking of Statistics-related issues and problems;

(iii) Communication skills involving the ability to listen carefully, to read texts and reference material analytically and to present information in a concise manner to different groups/audiences of technical or popular nature;

(iv) Analytical skills involving paying attention to details and ability to construct logical Arguments using correct technical language related to Statistics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi) Personal skills such as the ability to work both independently and in a group.

11. Undertake research projects by using research skills- preparation of questionnaire, conducting national sample survey, research projects using sample survey, sampling techniques.

12. Understand and apply principles of least squares to fit a model to the given data, study the association between the variables, applications of Probability Theory and Probability Distributions.

Assessment

Weightage for assessments (in percentage)

Type of Course	**Formative Assessment / IA**	**Summative Assessment**
Theory	**40**	**60**
Practical	**Not applicable**	**Not applicable**
Projects	**Not applicable**	**Not applicable**
Experiential Learning (Internships etc.)	**Not applicable**	**Not applicable**

Summary of Discipline Specific Courses (DSC)		
Semester	**Course Code**	**Title of the Paper**
I	DSC B1	Descriptive Statistics – I
	DSC B2	Descriptive Statistics –II
II	DSC B3	Probability and Distributions
	DSC B4	Statistics for Economics
III	DSC B5	Exact Sampling Distributions and Statistical Inference
	DSC B6	Sampling Techniques
IV	DSC B7	ANOVA and Design of Experiments
	DSC B8	Regression Analysis and Econometrics
V	DSC B9	Statistical Quality Control
VI	DSC B10	Operations Research

Open Electives

I	OE 1	Statistics in Competitive Examinations
II	OE 2	Statistical Methods
III	OE 3	Business Statistics
IV	OE 4	Quantitative Aptitude

Curriculum Structure for the Undergraduate Degree Program B.A.

Total Credits for the Program: 176 **Starting year of implementation: 2021-22**
Name of the Degree Program: B.A **Discipline/Subject: Applied Statistics**

Program Articulation Matrix:

This matrix lists only the core courses. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses may be listed separately

Semester	Title /Name Ofthe course	Program outcomes that the course addresses (not more than 3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment$
1	**Descriptive Statistics-I**	PO1,PO2,PO8	12^{th} level in any discipline	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.	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.
1	**Descriptive Statistics-II**	PO5, PO6	12^{th} level in any discipline	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	
2	**Statistics for Economics**	PO3,PO8,PO10	12^{th} level in any discipline	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	The assessment is done using continuous assessment through written test, open book examination, viva-voce, seminars, and group discussions.

2	**Probability and Distributions**	PO5, PO6	12^{th} level in any discipline	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	

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project based learning/ case studies/self study like seminar, term paper or MOOC

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning).

BA

Semester 1

Course Title: B.A	
Total Contact Hours: 42	Course Credits:3
Formative Assessment Marks: 30	Duration of ESA/Exam: 3hours
Model Syllabus Authors: State level model curriculum setting committee members-Statistics	Summative Assessment Marks: 70

Course Pre-requisite(s): II PUC in any discipline

Course Outcomes (COs)

At the end of the course the student should be able to:

1. Organize, manage and present data.
2. Analyze statistical data graphically using frequency distributions and cumulative frequency distributions.
3. Analyze statistical data using measures of central tendency, dispersion.
4. Understand Skewness and Kurtosis and their use in studying various characteristics of data.
5. Know concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient.
6. Carryout spatial analysis.
7. Understand the Price and Quantity Index numbers and their different measures, understand the applicability of cost of living Index number.
8. Know the components and Need for Time series, understand the different methods of studying trend and Seasonal Index.
9. Solve problems of economics concerns using demand analysis, supply functions, Gini's coefficient and Lorenz Curve.
10. Understand basic concepts, important theorems on probability and their use in solving problem.
11. Know random variable, mathematical expectation, and numerical problems on mathematical expectation.
12. Understand the most common discrete and continuous probability distributions and their real life applications.
13. Understand the nature of data and to perform appropriate analysis.

14. Carry out time series analysis and predict the future values of given trend.

15. Analyze the Seasonal Indies by using different methods.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Organize, manage and present data.	X	X		X								
2. Analyze statistical data graphically using frequency distributions and cumulative frequency distributions.	X						X					
3. Analyze statistical data using measures of central tendency, dispersion.				X				X		X		
4. Understand Skewness and Kurtosis and their use in studying various characteristics of data.			X									
5. Know concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient.			X									
6. Carryout spatial analysis.							X					
7. Understand the Price and Quantity Index numbers and their different measures, understand the applicability of cost of living Index number.									X	X		
8. Know the components and Need for Time series, understand the different methods of studying trend and Seasonal Index.	X								X	X		
9. Solve problems of economics concerns using demand analysis, supply functions, Gini's coefficient and Lorenz Curve.									X	X		
10. Understand basic concepts, important theorems on probability and their use in solving problem.											X	
11.Know random variable, mathematical expectation, and numerical problems on mathematical expectation.	X										X	
12. Understand the most common discrete and continuous probability distributions										X		

and their real life applications.												
13. Understand the nature of data and to perform appropriate analysis.											X	X
14. Carry out time series analysis and predict the future values of given trend.											X	X
15. Analyze the Seasonal Indies by using different methods.	X										X	X

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomeswhose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

BA Semester 1

Title of the Course: Applied statistics

Course 1: Descriptive Statistics-I		**Course 2:Descriptive Statistics-II**	
Number of Theory Credits	**Number of lecture hours/semester**	**Number of Theory Credits**	**Number of lecture hours/semester**
3	**42**	**3**	**42**

Content of Course 1: Descriptive Statistics-I	**42 Hrs**
Unit – 1 :Introduction to Statistics and Basic Concepts	**12 Hrs**
Meaning, origin, definition, functions, limitations and applications of Statistics. Primary and secondary data, different methods of collection of primary data with merits and demerits. Sources of secondary data. Classification: meaning, objectives, types of classifications- Chronological, Geographical, Qualitative and Quantitative classifications with illustrations. Definition of some important terms - class, class limits, class intervals, width of class interval, open-end classes, inclusive and exclusive classes. Formation of discrete and continuous frequency distributions. Tabulation: meaning, objectives and rules of tabulation, format of a statistical table and its parts. Types of table, examples of preparation of a blank table and tables with numerical information.	
Unit – 2 :Diagrammatic and Graphical representation of Data	**10 Hrs**
Diagrams: Meaning, importance of diagrams and general rules of construction of diagrams. Types of Diagrams – simple, multiple, component, percentage bar diagrams and pie diagrams with simple illustrations. Graphs: Types of Graphs – Histogram, frequency Polygon, frequency curve and Ogives, simple problems, location of mode, median and partition values from the graphs. Difference between diagrams and graphs.	

Unit – 3:Measures of Central Tendency	**10 Hrs**
Meaning of central tendency and essentials of a good measure of central tendency. Types of measures of central tendency: Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean - definition, merits and demerits. Properties of arithmetic mean. Empirical relation between mean median and mode. Problems on both grouped and ungrouped data for all the measures. Partition values-definition and types of partition values: quartiles, deciles and percentiles. Problems on Quartiles for grouped ungrouped data only.	
Unit – 4:Measures of Dispersion	**10 Hrs**
Meaning and objectives of measures of dispersion. Essentials of a good measure of dispersion, absolute and relative measures of dispersion. Types of measures of dispersion- Range, Quartile deviation, Mean deviation and standard deviation with relative measures – definition, merits and demerits. Properties of Standard deviation, simple problems on ungrouped and grouped data. **Skewness and Kurtosis:** Skewness- Definition, objectives and types of skewness, explanation of positive and negative skewness with diagrams. Measures of skewness- Karl Pearson's coefficient of skewness and Bowley's coefficient of skewness. Simple problems. Kurtosis: Definition and types of kurtosis. Explanation of types of kurtosis with neat diagrams. Measure of skewness based on moments. Difference between skewness and kurtosis.	

References

1. Gani S. G., Sankhyshastra and Ganakayantra. Udaya Ravi Publications, Bijapur.
2. Gupta S. C. Fundamentals of Statistics, Himalaya Publishing House, Bombay
3. Mukhopadhaya, P. Applied Statistics, New Central Book Agency (P) Ltd., Calcutta
4. Gupta S P. and V K Kapoor Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Course 2:Descriptive Statistics-II	42 Hrs
Unit – 1 :Correlation	**12 Hrs**
Definition of relationship, Definition, Types of correlation, Methods of measuring correlation, Scatter diagram, Correlation Coefficient for quantitative data: Prof. Karl Pearson's coefficient of linear correlation, its properties, Correlation Coefficient for qualitative data: Spearman's rank correlation coefficient, its properties. Simple regression analysis- regression equations by method of least squares, linear regression coefficients and its properties. Angle between the regression lines.	
Unit – 2: Association of Attributes	**10 Hrs**
Meaning of association of attributes, definition of class of the first order and second order. Methods of studying association. Yule's coefficient of association and its interpretation. Determination of Yule's coefficient of association in case of two attributes.	
Unit – 3: Spatial Statistics	**10 Hrs**
History and introduction, spatial characterization, spatial dependence, spatial auto correlation, spatial association, spatial scaling, spatial sampling, errors in spatial analysis.	
Unit:4: Multivariate data Analysis	**10 Hrs**
Introduction: Yule's notations, distribution of two variables, distribution of three or more variables, primary and secondary subscripts, Plane of regression and its derivation, estimation of regression coefficients a and b in case of three variables, partial regression coefficient in terms of delta, Residual, properties of residuals, Standard deviation of residuals, Multiple and partial correlation, definition, derivation and their standard properties.	

References

1. Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.
2. Anderson T.W. and Jeremy D. Finn (1996). The New Statistical Analysis of Data, Springer
3. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
4. Gani S. G., Sankhyshastra and Ganakayantra. Udaya Ravi Publications, Bijapur.
5. Gupta S. C. Fundamentals of Statistics, Himalaya Publishing House, Bombay
6. Gupta S P. and V K Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

Date 14-09-2021 Course Co-ordinator Subject Committee Chairperson

BA Semester 2

Title of the Course: Applied Statistics

Course 3: Statistics for Economics		Course 4:Probability and Distributions	
Number of Theory Credits	**Number of lecture hours/semester**	**Number of Theory Credits**	**Number of lecture hours/semester**
3	**42**	**3**	**42**

Content of Course 3: Statistics for Economics	42 Hrs
Unit – 1 :Supply and Demand	**10 Hrs**
How Markets Work, Markets and Welfare Markets and competition; determinants of individual demand/supply; demand/supply schedule and demand/supply curve; market versus individual demand/supply; shifts in the demand/supply curve, demand and supply together; how prices allocate resources; elasticity and its application; controls on prices; taxes and the costs of taxation; consumer surplus; producer surplus and the efficiency of the markets.	
Unit – 2:Measuring income inequality: Lorenz curve & Gini Coefficient	**10 Hrs**
Measuring income inequality: Pareto law of Distribution, Lorenz curve and Gini's Coefficient, Limitations and interpretations of GC.	
Unit – 3:Index numbers	**12 Hrs**
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, factor reversal test, and Circular 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 Hrs**
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. Gupta S. C. Fundamentals of Statistics, Himalaya Publishing House, Bombay
2. Mukhopadhaya, P. Applied Statistics, New Central Book Agency (P) Ltd., Calcutta
3. Gupta S P. and V K Kapoor Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi.

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 2	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

Content of Course 4: Probability and Distributions	**42 Hrs**
Unit – 1 :Introduction to Probability	**10 Hrs**
Introduction to probability, Basic concepts: Random experiment, Sample space, Mutually exclusive, exhaustive, equally likely events, complimentary events, classical, statistical and axiomatic definition of probability, properties, Addition theorem of Probability and Definition of independent, dependent events, Conditional probability, Multiplication theorem of Probability without proof. Simple numerical problems.	

Unit – 2:Random Variable and Mathematical Expectation	**10 Hrs**
Definition of a random variable, discrete & continuous random variable, probability mass function, probability density function, distribution function. Definition of mathematical expectation, expected mean and variance of discrete random variable. Properties of Mathematical expectation. Statement of addition and multiplication theorem of expectation. Numerical problems on mathematical expectation.	
Unit – 3:Discrete Distributions	**12 Hrs**
Binomial Distribution: Definition of Binomial Distribution, mean and Variance of Binomial distribution, numerical problems on binomial distribution. Uses of binomial distribution. Fitting of Binomial distribution and obtaining expected probabilities. Simple problems. **Poisson Distribution:** Definition of Poisson distribution. Mean, Variance and its properties of Poisson variate. Uses of Poisson distribution. Simple problems on Poisson distribution. Computing probabilities for large n and small p for the given λ, finding λ for given two successive probabilities. Conditions for Poisson distribution as limiting form of Binomial distribution. Fitting of Poisson distribution.	
Unit – 4 : Normal Distribution	**10 Hrs**
Definition of normal variate. Application of Normal distribution Definition of standard normal variate, standard normal distribution and properties of normal curve. Conditions under which binomial distribution tend to normal distribution (Statement only). Finding probabilities and expected numbers when mean and variance are given quartile deviation, mean deviation and standard deviation and problems.	

References

1. Gupta S. C. Fundamentals of Statistics, Himalaya Publishing House, Bombay
2. Mukhopadhaya, P. Applied Statistics, New Central Book Agency (P) Ltd., Calcutta
3. Gupta S P. and V K Kapoor Fundamentals of Mathematical Statistics, Sultan Chand, New Delhi.
4. Gani S. G., Sankhyshastra and Ganakayantra. Udaya Ravi Publications, Bijapur.

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: 30 marks	
Assessment Occasion/ type	**Weightage in Marks**
Internal Test 1	1/3
Internal Test 1	1/3
Assignment/Seminar (7 marks)+Attendance(3marks)	1/3
Total	01

14-09-2021
Date Course Co-ordinator Subject Committee Chairperson

List of Open Electives

1. Statistics in Competitive Examinations
2. Statistical Methods
3. Business Statistics
4. Quantitative Aptitude

1. Statistics in Competitive Examinations (Open Elective)

Course Objectives

To train the students to solve the problems of statistics that appear in most of the competitive exams conducted by Banking, State and Central Governments and other agencies.

Course Outcomes (CO)

After the successful completion of the course, the students will be able to develop the data analysis skills required for Competitive Examinations.

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: Collection Classification and Presentation of Statistical Data (6 hours)

Primary and Secondary data, Methods of data collection; Tabulation of data; Graphs and charts; Frequency distributions; Diagrammatic presentation of frequency distributions.

Unit 2: Measures of Central Tendency and Dispersion (12 hours)

Meaning of central tendency and essentials of a good measure of central tendency. Types of measures of central tendency, Arithmetic mean, Median, Mode, Geometric mean and Harmonic mean - definition, merits and demerits. Properties of arithmetic mean. Empirical relation between mean median and mode. Problems on both grouped and ungrouped data for all the measures.

Partition values-definition and types of partition values: quartiles, deciles and percentiles. Problems on Quartiles for grouped ungrouped data only.

Meaning and objectives of measures of dispersion. Essentials of a good measure of dispersion, absolute and relative measures of dispersion. Types of measures of dispersion- Range, Quartile deviation, Mean deviation and standard deviation with relative measures – definition, merits and demerits. Properties of Standard deviation, simple problems on ungrouped and grouped data.

Unit 3: Aptitude Ability and Reasoning **(14 hours)**

Area, Banker's Discount, Surds and Indices, Ratio and Proportion, Simple Interest, Problems on Trains, Profit and Loss, Compound Interest.

Reasoning: Number series, Analogy, Classifications, Blood relations Coding-decoding, Puzzle test, Logical Venn diagram. Alphabet-test, Alpha-numerical sequence puzzle, Mathematical operations, Numbers, ranking & time sequence test, Logical sequence test, Arithmetical operations.

Unit 4: Introduction to Probability **(10 hours)**

Introduction to probability, Basic concepts: Random experiment, Sample space, Mutually exclusive, exhaustive, equally likely events, complimentary events, classical, statistical and axiomatic definition of probability, properties, Addition theorem of Probability and Definition of independent, dependent events, Conditional probability, Multiplication theorem of Probability without proof. Simple numerical problems.

References

1. Freedman, D., Pisani, R. and Purves, R. (2014), Statistics, 4th Edition, W. W. Norton & Company.
2. Gupta S. C. Fundamentals of Statistics, Himalaya Publishing House, Bombay.
3. Gani S. G., Sankhyshastra and Ganakayantra. Udaya Ravi Publications, Bijapur

2. Statistical Methods (Open Elective)

Course Objectives

This is an open elective course for social science and life science students.

The students will learn the elements of descriptive statistics, probability, statistical methods such as tests of hypotheses, correlation and regression.

Course Outcomes (CO)

Students will be able to

CO1. Acquire the 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. MukhyopadyayaP(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

3. 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 Chandand 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.

4. Quantitative Aptitude (Open Elective)

Course Objective

To train the students in the aspects of numerical ability, reasoning techniques and mental ability for competitive examinations conducted by various public and private boards.

Course Outcomes (CO)

After the successful completion of the course, the students will be able to develop the general skills required to Competitive Examinations.

Pedagogy

Activity based teaching and learning along with theoretical aspects using classroom teaching, group discussions and seminars.

Contents

Unit 1: Numerical Aptitude I **(10 hours)**

Number Systems, Computation of Whole Numbers, Decimals and Fractions and relationship between Numbers, Fundamental arithmetical operations.

Unit 2: Numerical Aptitude II **(12 hours)**

Percentages, Ratios and Proportions, Average, interest, Profit and Loss, Discount use of Tables and Graphs Time and Distance, Ratio and Time, Time and Work.

Unit 3: Reasoning and Mental Ability I **(10 hours)**

Coding-Decoding, Symbol notations, Number Series, Analogy & Classification , Blood relations, Direction Sense, Liner arrangement.

Unit 4: Reasoning and Mental Ability II **(10 hours)**

Ranking and Comparison, Input & output, Assumptions, Conclusion & Inferences.

References:

1. Agarwal R.S., Quantitative Aptitude: by, Publication by S, Chand
2. Ningappa A H ,Mental Ability: Ashok Publication.