Bangalore University

Department of Statistics

Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
I & II Semester Discipline Core-Statistics
Under-Graduate (UG) Program
Framed according to the National Education Policy (NEP 2020)

Bangalore University
Department of Statistics

Proceedings of the Meeting of Board of Studies in Statistics(UG & PG) held at 10:30am on Tuesday, 22-09-2021 in the Department of Statistics, BUB

Members Present:

1. Prof. Parameshwar V Pandit, - Chairperson
Chairperson, BOS, BUB Department of Statistics
Bangalore University, Bengaluru

2. Dr. Satish S. Bhat - Member
Associate Professor, Department of Statistics
Yuvaraja College, Mysore

3. Dr. V. Srinivas - Member
Associate Professor, Department of Statistics, BUB

4. Dr. Suresh, R. - Member
Assistant Professor, Department of Statistics, BUB

5. Dr. Mallappa - Member
Assistant Professor, Department of Statistics, BUB

6. Dr. Mohini Bhat - Member
Assistant Professor, Christ Institute of Advanced Studies, Bengaluru

7. Divya, V. R. - Member
Assistant Professor, St. Clariet College, MES Ring Road, Jalahalli
Bengaluru

8. Sri. Kagendra, T. - Member
Assistant Professor, Oxford College of Science, HSR Layout
Bengaluru

The chairman welcomed the local members to the meeting of Board of Studies in Statistics. The members actively participated in the discussion of framing the syllabus for I and II semester and the structure, scheme for entire undergraduate/postgraduate programmes as per NEP 2020 guidelines.

The board arrived at the following dicisions:

1. The members finalized the structure, scheme of assessment for BSc, BSc(Honours) and MSc (integrated) for Statistics as Major and Minor.
2. The members finalized the content of the syllabus for I and II semesters of Statistics as major and minor for undergraduate programme.

Dr. Satish S. Bhat 22/9/21 | Dr. V. Srinivas | Dr. Suresh, R | Dr. Mallappa 22/09/21

Divya, V.R 22/9/21 | Dr. Mohini Bhat 22/9/21 | Kagendra 22/9/21

22/09/2021

Prof. Parameshwar V. Pandit Chairman, BoS

Dr. Parameshwar V. Pandit
Professor and Chairperson
Department of Statistics
Bangalore University
Bengaluru - 560 056.

BANGALORE UNIVERSITY

Regulations and Syllabus
for
STATISTICS
in
B.Sc. and B.Sc. (Honours) Course (CBCS 2021)

Preamble

Several reforms in our education system has been proposed and developed by Ministry of HRD as National Education Policy (NEP)2020 which includes broad based multidisciplinary undergraduate education with necessary knowledge, skills and competencies. It also proposes to bring equity, efficiency and academic excellence at different levels of education. NEP also recommended multidisciplinary undergraduate programmes with multiple exit and multiple entry options with the provision of Certificate/Diploma/Degrees at each of the exits.

Probability and Statistics is the language of uncertainties, riddled modern information age. Statistics facilitates the decision making process by quantifying the element of chance or uncertainties. Its descriptive and inferential procedures not only formulate the basis of the growth of almost all disciplines of the contemporary world, and also provide an array of employment avenues in all fields. This is a rigorous program in Probability Theory, Statistical Inference, Multivariate Analysis, Linear Models and Regression Analysis and Sample surveys and Design of Experiments designed to give a sound foundation in fundamentals and training in practical Statistics leading to statistical data analysis.

The eight semester 176 credit program has a variety of elective courses to choose from including enough courses on statistical software. A person successfully completing the program will have enough knowledge and expertise to statistically analyze small and large univariate and multivariate data sets, pursue advanced courses in Statistics or a Ph.D. in Statistics, work in software/data analytics industry as domain expert, independently consult for statistical data analysis.

In this direction, the Board Studies in Statistics (PG&UG) approved the syllabus along with structure and schemes for BSc, BSc (Honours and MSc programmes. The Board of Studies consists of experts as below:

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

2. Dr. Surekha B Munoli - Member
Professor, Department of Statistics
Karnataka University,Dharwad.

3. Dr Sujata Inginshetty - Member
Professor and Chairperson, Department of Statistics
Gulbarga University, Kalaburgi

4. Dr. Kala R. Nayak - Member
Registrar, Don Bosco College of Engineering,
Fatoda, Madgao, Goa

5. Dr. Satish S. Bhat - Member
Associate Professor, Department of Statistics
Yuvaraja College, Mysore

6. Dr. V. Srinivas - Member
Associate Professor, Department of Statistics
Bangalore University, Bengaluru

7. Dr. Suresh, R. - Member
Assistant Professor, Department of Statistics
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8. Dr. Mallappa - Member
Assistant Professor, Department of Statistics
Bangalore University, Bengaluru

9. Dr. Mohini Bhat - Member
Assistant Professor, Department of Statistics
Christ Institute of Advanced Studies, Christ Nagar
Begur-Koppa Road, Sakkalawara Post, Bengaluru

10. Divya, V. R. - Member
Assistant Professor, Department of Statistics
St. Clariet College, MES Ring Road, Jalahalli
Bengaluru

11. Sri. Kagendra, T. - Member
Assistant Professor, Department of Statistics
Oxford College of Science, HSR Layout
Bengaluru

Eligibility

Only those candidates who have passed XII/Pre-University Course in Science or an equivalent course with Mathematics/ Basic Mathematics/Applied Mathematics as one of the optional subjects are eligible to take Statistics as one of the optional subjects in BSc course.

Scheme of Instruction/ Examination

1. The subject of Statistics in this course has to be taught by MSc/MA degree holders in Statistics / Applied Statistics.
2. The theory question paper for each paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
3. The practicals are to be conducted in batches as per the University norms for the faculty of science (normally 10 students per batch per teacher).
4. Two teachers are to be assigned for each batch with not more than 20 students for giving instructions, supervision, and correction of records.
6. It is expected that each student collects and uses real life data for the practical classes.
7. Students are required to use Statistical software, run the programmes, and enclose computer outputs to the practical records in the case of computer based practicals.
8. Maximum marks for each record in the examination is 5.
9. Study tour for the students is strongly recommended to gain practical knowledge of applications of Statistics in Industries/Agriculture/Medical field.

Progressive Certificate, Diploma, Bachelor Degree or Bachelor Degree with Honours Provided at the End of Each Year of Exit of the Four-year Undergraduate Programme/ Five-year Integrated Master's Degree Programme

EXIT OPTIONS	Credits required
Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	44 - 48
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	88 - 96
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme/Five-year Integrated Master's Degree Programme	132 - 144
Bachelor Degree with Honours in a Discipline at the Successful Completion of the Fourth Years (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	176 - 192
Master's Degree in a Discipline at the Successful Completion of the Fifth Year (Ten Semesters) of the Five- year Integrated Master's Degree Programme	224- 240

Name of the Degree Program: B.Sc.

Discipline Core: Statistics 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 abilities 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 modeling 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**

Scheme for Theory and Practicals

1. Statistics as Major Subject and any other subject as Minor

Sem.	Code number	Title of the paper (Theory / Practical)	Lecture/ Practical hours per week	Duration of exam	IA marks	Maximum marks	Total	Credits
I	STAT 101	Descriptive Statistics	04	03	40	60	100	4
	STAT 102	Practical –I	04	03	25	25	50	2
II	STAT 201	Probability and Probability Distributions	04	03	40	60	100	4
	STAT 202	Practical –II	04	03	25	25	50	2
III	STAT 301	Calculus and Probability Distributions	04	03	40	60	100	4
	STAT 302	Practical –III	04	03	25	25	50	2
IV	STAT 401	Statistical Inference-I	04	03	40	60	100	4
	STAT 402	Practical –IV	04	03	25	25	50	2
V	STAT 501	Matrix Algebra and Regression Analysis	03	03	40	60	100	3
	STAT 502	Analysis of Variance and Design of Experiments	03	03	40	60	100	3
	STAT 503	Practical –V	04	03	25	25	50	2
	STAT 504	Practical –VI	04	03	25	25	50	2
	STAT 505	Elective – 1	03	03	40	60	100	3
VI	STAT 601	Statistical Inference-II	03	03	40	60	100	3
	STAT 602	Sampling Theory and Statistics for National Development	03	03	40	60	100	3
	STAT 603	Practical –VII	04	03	25	25	50	2
	STAT 604	Practical –VIII	04	03	25	25	50	2
	STAT 605	Elective – II	03	03	40	60	100	3
VII	STAT 701	Real Analysis and linear Algebra	03	03	40	60	100	3
	STAT 702	Probability Theory	04	03	40	60	100	4
	STAT 703	Sampling Theory	03	03	40	60	100	3
	STAT 704	Practical –IX	04	03	25	25	50	2
	STAT 705	Practical –X	04	03	25	25	50	2
	STAT 706	Elective – III	03	03	40	60	100	3
	STAT 707	Research Methodology	03	03	40	60	100	3
VIII	STAT 801	Distribution Theory	03	03	40	60	100	3
	STAT 802	Statistical Inference-III	03	03	40	60	100	3
	STAT 803	Linear Models and Regression Analysis	03	03	40	60	100	3
	STAT 804	Practical –XI	02	03	25	25	50	2
	STAT 805	Elective – IV	03	03	40	60	100	3
	STAT 806	Research Project	06					6

IX	**STAT 901**	**Multivariate Analysis**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT 902	**Statistical Inference-III**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 903	**Stochastic Processes**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT 904	**Practical –XII**	**04**	**03**	**25**	**25**	**50**	**2**
	STAT 905	**Practical –XIII**	**04**	**03**	**25**	**25**	**50**	**2**
	STAT 906	**Elective – V**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT907	**Research Methodology**	**03**	**03**	**40**	**60**	**100**	**3**
X	**STAT 1001**	**Design and Analysis of Experiments**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 1002	**Statistical Inference-III**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT 1003	**Time series analysis**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 1004	**Elective – VI**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT 1005	**Research Project**	**06**	**Report**	**60**	**90**	**150**	**6**

2. Statistics as Discipline Core (Minor) Subject and any other subject as Major

Sem.	Code number	Title of the paper (Theory / Practical)	Lecture/ Practical hours per week	Duration of exam	IA marks	Maximum marks	Total	Credits
I	**STAT 101**	**Descriptive Statistics**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 102	**Practical –I**	**04**	**03**	**25**	**25**	**50**	**2**
II	**STAT 201**	**Probability and Probability Distributions**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 202	**Practical –II**	**04**	**03**	**25**	**25**	**50**	**2**
III	**STAT 301**	**Calculus and Probability Distributions**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 302	**Practical –III**	**04**	**03**	**25**	**25**	**50**	**2**
IV	**STAT 401**	**Statistical Inference**	**04**	**03**	**40**	**60**	**100**	**4**
	STAT 402	**Practical –IV**	**04**	**03**	**25**	**25**	**50**	**2**
V	**STAT 501**	**Regression Analysis, Analysis of Variance**	**03**	**03**	**40**	**60**	**100**	**3**
	STAT 502	**Practical –V**	**04**	**03**	**25**	**25**	**50**	**2**
VI	**STAT 601**	**Sampling Theory and Design of Experiments**	**03**	**03**	**40**	**70**	**100**	**3**
	STAT 602	**Practical –VI**	**04**	**03**	**25**	**25**	**50**	**2**

List of Discipline Specific Electives (DSE)	List of Open Electives
• Actuarial Statistics • Advanced Statistical Inference • Analysis of Categorical Data • Analysis of Clinical Trials • Artificial Intelligence with R • Bayesian Inference • Bio-Statistics • Computational Statistics • Data Science with R/Python • Demography • Extreme value Theory • Financial Statistics • Econometrics • Multivariate Techniques • Nonparametric and Semiparametric Methods • Operations Research • Project Work • Reliability Analysis • Reliability and Statistical Quality Control • Statistical Learning and Data Mining with R/Python • Statistical Quality Control • Stochastic Models in Finance • Survival Analysis • Sampling Theory and Applications • Machine Learning	• Statistical Methods • Business Statistics • Applied Statistics • 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 for I and II semester B.Sc. Core courses are essential to earn the degree in that discipline/subject. They include courses such as theory, laboratory, project, internships etc. Elective courses are listed separately.

Semester	Title /Name Of the course	Program outcomes that the course addresses	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 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.

STATISTICS
Syllabus for Statistics (as Major as well as Minor)

I SEMESTER
Theory

Course Title: Descriptive Statistics	Course Code: S 101
Contact Hours per Week: 4 Hours	Total Contact Hours: 56 hours
Course Credits:04	Duration of ESA/Exam: 3hours
Formative (Internal) Assessment Marks: 40	Summative Assessment Marks: 60

Unit – 1 : Introduction to Statistics	**13 Hrs**
Statistics: Definition and scope. Concepts of statistical population and sample, drawing samples using: Simple random sampling, Stratified, Systematic and Cluster sampling methods (concepts only). Data: quantitative and qualitative, cross sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Collection of data, 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. Moments, Skewness and Kurtosis. Quantiles and measures based on them. Box Plot. Outliers. Chebyshev's inequality. Analysis of Qualitative data (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 (Three Variables only), Residual variance. Multiple and partial correlation coefficients. (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 (Internal) Assessment: Total 40 marks	
Assessment Occasion/ type	**Split in Marks**
Attendance	05
Internal Test (Minimum of 2)	20
Assignments/Seminars/Case study /Project report etc	15
Total	40

Practical

Course Title: Practical –I	Course Code: S 102
Contact Hours per Week: 4 Hours	Total Contact Hours: 52 hours
Course Credits: 02	Duration of ESA/Exam: 3hours
Formative (Internal) Assessment Marks: 25	Summative Assessment Marks: 25

List of Practical Assignments (Computation 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. Product moment correlation coefficient, rank correlation and Kendal's coefficient.
7. Fitting of curves by least squares method.
8. Regression of two and three variables.
9. Multivariate Descriptive statistics mean Vector, dispersion matrix, correlation matrix, Partial and Multiple correlation.
10. Problems on Association of attributes.

Formative (Internal) Assessment: Total 25 marks	
Assessment Occasion/ type	**Split in Marks**
Practical test	10
Assignments/Seminars/Case study /Report etc	10
Total	25

II SEMESTER
Theory

Course Title: Probability and Distributions	Course Code: S 201
Contact Hours per Week: 4 Hours	Total Contact Hours: 56
Course Credits:04	Duration of ESA/Exam: 3hours
Formative (Internal) Assessment Marks: 40	Summative Assessment Marks: 60

Unit –1 : Probability	**12 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, Probability generating function, Moments and moment generating function – properties and uses.	
Unit –3: Standard Distributions	**16 Hrs**
Bernoulli, Binomial, Poisson, Geometric and Rectangular distributions– mean, variance, moments and m. g. f. recursive relations for probabilities and moments of Binomial and Poisson distributions, Uniform, Exponential, Normal distributions and their 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.	

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1. Dudewicz. 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: 40 marks	
Assessment Occasion/ type	**Split in Marks**
Attendance	05
Internal Test (Minimum of 2)	20
Assignments/Seminars/Case study /Project report etc	15
Total	40

Practical

Course Title: Practical – II	Course Code: S 202
Contact Hours per Week: 4 Hours	Total Contact Hours: 40 hours
Course Credits: 02	Duration of ESA/Exam: 3hours
Formative (Internal) Assessment Marks: 25	Summative Assessment Marks: 25

List of Practical Assignments (Computation 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. Plotting pmf and sketching of pdf.
5. Problems on expectation, variance, quantiles, skewness, kurtosis (Discrete Case).
6. Problems on pdf, expectation, variance, quantiles, skewness, kurtosis (Continuous case).
7. Problems on discrete probability distributions (Rectangular, Binomial, Poisson and Geometric)
8. Problems on Normal probability distributions
9. Computation of moments and Moment generating functions (Discrete and Continuous Case) and extraction of probabilities probability generating function.
10. Fitting of distributions Binomial, Poisson, Geometric distributions.
11. Fitting of distributions Exponential and Normal distributions

Formative (Internal) Assessment: Total 25 marks	
Assessment Occasion/ type	**Split in Marks**
Practical test	15
Assignments/Seminars/Case study /Report etc	10
Total	25

List of Open Electives (OE)

First Semester

1. **Statistical Methods**
2. **Business Statistics**

Second Semester

1. **Applied statistics**
2. **Biostatistics**

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

Total Numbers Teaching Hours: 42

Unit 1: Introduction **13 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.

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

Unit 2: Bivariate Data Analysis and Probability **14 Hours**

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.

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.

Unit 3: Probability Distributions, Sampling Distributions and Testing of Hypothesis **15 Hours**

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

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.

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

Total Numbers Teaching Hours: 42

Unit 1: Statistical Data and Descriptive Statistics **13 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 **13 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 and Time Series **16 Hours**

Index Numbers: 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.

Time Series Analysis: 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.

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 and Statistical Quality Control **16 Hours**

Sampling Theory: 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.

Statistical Quality Control: 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.
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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.

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

Total Number of Teaching Hours: 42

Unit 1: Introduction to Bio-Statistics and Univariate Analysis **14 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.

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

Unit 2: Bivariate Analysis **14 hours**

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.

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).

Unit 3: Probability Distributions, Sampling Distributions and Statistical Inference 14 Hours

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).

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.

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