ST.JOSEPH'SCOLLEGE(AUTONOMOUS)

BENGALURU-27

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by NAAC
Recognized by UGC as College of Excellence

DEPARTMENT OF STATISTICS

SYLLABUS FOR UNDERGRADUATE PROGRAMME

For Batch 2021-2024

Part B

B.Sc. EMS Curriculum

Courses and course completion requirements	No. of credits
General English	12
Second language: Introductory Kannada/Kannada/ Hindi/ Sanskrit/ Tamil/ Additional English/French/German.	12
Economics	
Mathematics	
Statistics	38
Open elective courses (non-professional)	6
Foundation courses	
Term paper	
Soft skills (IGNITORS)	
Human resource development (HRD)/Theology	
Outreach activity	
Extra and Co-curricular activities	5

B.Sc. CMS Curriculum

Courses and course completion requirements	No. of credits
General English	12
Second language: Introductory Kannada/Kannada/ Hindi/ Sanskrit/ Tamil/ Additional English/French/German.	12
Computer Science	
Mathematics	
Statistics	38
Open elective courses (non-professional)	6
Foundation courses	
Term paper	
Soft skills (IGNITORS)	
Human resource development (HRD)/Theology	
Outreach activity	
Extra and Co-curricular activities	5

SUMMARY OF CREDITS IN STATISTICS

DEPARTMENT OF STATISTICS (UG) (2021-2024)								
Semester 1	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of Hours of teaching per week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	ST-121	Introduction to Statistics and Probability	60	04	04	30	70	100
Practical	ST-1P1	Practical on ST-121	33	03	01.5	15	35	50
Total Number of credits:			05.5					
Semester 2	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	ST-221	Theoretical Probability Distributions	60	04	04	30	70	100
Practical	ST-2P1	Practical on ST-221	33	03	01.5	15	35	50
Total Number of credits:			05.5					
Semester 3	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	ST-321	Statistical Inference I	60	04	04	30	70	100
Practical	ST-3P1	Practical on ST-321	33	03	01.5	15	35	50
Total Number of credits:			05.5					
Semester 4	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Continuous Internal Assessment (CIA) Marks**	**End Semester Marks**	**Total marks**
Theory	ST-421	Statistical Inference II	30	02	02	15	35	50
Theory	STOE-4121	First Course in Statistics	30	02	02	15	35	50
Practical	ST-4P1	Practical on ST-421	33	03	01.5	15	35	50
Total Number of credits:			03.5					

Semester 5	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	ST-5121	Sampling Theory and Design of Experiments	45	03	03	30	70	100
Practical	ST-5P1	Practical on ST-5121	33	03	01.5	15	35	50
Theory	ST-5221	Statistical Methods for Quality Management	45	03	03	30	70	100
Practical	ST-5P2	Practical on ST-5221	33	03	01.5	15	35	50
Total Number of credits:							09	

Semester 6	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	ST-6121	Applied Statistics	45	03	03	30	70	100
Practical	ST-6P1	Practical on ST-6121	33	03	01.5	15	35	50
Theory	ST-6221	Operations Research	45	03	03	30	70	100
Practical	ST-6P2	Practical on ST-6221	33	03	01.5	15	35	50
Total Number of credits:							09	

CORE COURSES (CC)

Course Title	Code Number
Introduction to Statistics and Probability	ST-121
Theoretical Probability Distributions	ST-221
Statistical Inference I	ST-321
Statistical Inference II	ST-421
Sampling Theory and Design of Experiments	ST-5121
Statistical Methods for Quality Management	ST-5221
Applied Statistics	ST-6121
Operations Research	ST-6221

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

Course Title	Code Number

GENERIC ELECTIVE COURSES (GSE)/ Can include open electives offered	
Course Title	Code Number
First course in Statistics	STOE- 4121

SKILL ENHANCEMENT COURSE (SEC) – **Any practical oriented and software-based courses offered by departments to be listed below**	
Course Title	Code Number
Certificate course in SPSS and EXCEL	$ST\text{-}1P_2$

VALUE ADDED COURSES (VAC) **Certificate courses that add value to the core papers can be listed**	
Course Title	Code Number
Certificate courses in Data Science	

Online courses offered or recommended by the department to be listed	
Course Title	Code Number

B.Sc. Course in Statistics

First Semester

ST – 121: Introduction to Statistics and Probability

Semester	I
Paper Code	**ST-121**
Paper Title	**Introductionto Statistics and Probability**
Number of teaching hours per week	04
Total number of teaching hours per semester	60
Number of credits	04

Course objectives:

1. To acquire basic knowledge in statistics
2. To enable students to understand the importance of statistics
3. To train the students in computation of descriptive statistics
4. To help students to understand probability and its applications
5. To develop skills in handling and analyzing data using various software.

Unit- 1: Introduction to Statistics   10 hrs

a. Definition of Statistics and Importance of Statistics,   (2)
   Overview of Statistics – Case Study (not to be considered for exam)
b. Basic concepts – Population, Sample, Types of data – Primary and Secondary data; qualitative, quantitative, cross sectional, time series, variables and attributes, discrete and continuous variables. Types of scales - nominal, ordinal, ratio and interval.   (3)
c. Frequency distribution, Construction of Tables with one or more factors of classification and Graphical presentation – Histogram, Frequency curves, Cumulative frequency curves, Pie Chart, Stem and leaf diagram and Box plot   (5)

Unit-2: Exploratory Data Analysis: 22 hrs

a. Univariate data analysis:Measures of Central tendency and its applications, mean, weighted mean, median, mode, geometric and harmonic mean, properties and merits and demerits, relation between these measures.   (4)
   Measures of Location – Partition values, quartiles, deciles, percentiles.   (2)
   Measures of Dispersion, range, quartile deviation, mean deviation and standard deviation and their relative measures, properties.   (3)
   Moments – Raw, central and factorial moments, relation between them. Skewness and Kurtosis – their measures.   (3)

b. Bivariate data analysis:Correlation - Scatter diagram, Karl Pearson's correlation coefficient and its properties. Spearman's Rank correlation (4)

Regression - Simple linear regression analysis, least squares principles, regression coefficients and its properties, Interpretations of slope and intercept. Fitting of linear, multiple linear (only two independent variables), quadratic, exponential and geometric curves. (6)

Unit-3: Probability: 8 hrs

Random experiment, trial, sample space, events, classical, empirical and axiomatic approaches to probability. Properties of probability. Additive law, conditional probability, multiplicative law and their applications. Independence of events, Bayes' theorem- applications

Unit- 4: Univariate Probability Distribution theory 8 hrs

Definition of random variable, Discrete and continuous random variables. Probability mass function and probability density function. Discrete probability distribution and continuous probability distribution, Distribution function and its properties. Mathematical expectation and properties $(E(x), E(a), E(ax), E(ax\pm b), Var(x), Var(a), Var(ax), Var(ax\pm b))$, MGF and itsproperties. Transformation of univariate random variables.

Unit-5: Bivariate Probability Distribution theory 7 hrs

Two dimensional random variables. mean, variance, conditional expectation, covariance and correlation coefficient. Independence of random variables. Addition and multiplication theorems of expectation. Mean and variance of a linear combination of random variables. MGF and property of MGF for bivariate random variable, $M_{x+y}(t)$

Skill development exercises/programs/projects/case studies 5 hrs

Introduction to MS-Excel and R software
Sample projects and case studies covering applications of central tendency and dispersion
Sample projects and case studies covering applications of correlation and regression analysis
Report writing (explaining format of project report)

Books for Study

1. NG Das (2008), Statistical Methods combined volume, Tata McGraw-Hill
2. Tukey J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.
3. Freund JE and Walpole RE (1987) Mathematical Statistics (4th edition) PHI.
4. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics Vol.I, World Press, Calcutta.
5. Gupta, S.C., and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics: Sultan Chand & Sons.
6. Medhi J (1992): Statistical Methods: An introductory text. New Age.
7. Yule G. U& Kendall M.G. (1950): An Introduction to the Theory of Statistics, C.Griffin
8. Frederick Mosteller, John W. Tukey: (1977) Data Analysis and Regression: A Second Course in Statistics, Addison-Wesley Publishing Co.

References:

1. Anderson T.W. and Sclove S.L (1978) An Introduction to the Statistical Analysis of Data, Houghton Miffin& Co.
2. Mood A.M. Graybill F.A. and Boes D.C. (`1974): Introduction to the Theory of Statistics, McGraw Hill.
3. Snedecor G.W. and Cochran W.G. (1967): Statistical Methods. Iowa State University
4. KVS Sarma, Statistics Made Simple: Do it yourself on PC (PHI)
5. Purohit S.G. et.al. Statistics using R:
6. The Cartoon Guide to Statistics By Larry Gonick (Author) , Woollcott Smith (Author)
7. Doul
8. Putohith "Statistics Using R"

Resources for skill development exercises:

1. Curtis Frye: Microsoft Excel 2010 Step by Step, Microsoft
2. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
3. https://www.statmethods.net/
4. https://www.edx.org/
5. https://www.edx.org/course/analyzing-visualizing-data-excel-microsoft-dat206x-7
6. https://in.udacity.com/
7. http://www.statsoft.com/Textbook
8. https://www.datacamp.com/
9. https://vincentarelbundock.github.io/Rdatasets/datasets.html
10. https://www.coursera.org/learn/r-programming
11. https://www.kaggle.com/datasets
12. https://www.cooldatasets.com/

MODEL BLUEPRINT		
Code number:		**ST – 121**
Title of the paper:		**Introduction to Statisticsand Probability**
Unit number	**Number of hrs**	**Total marks**
1	10	18
2	22	40
3	8	15
4	8	15
5	7	13
Total	55	100
Maximum marks for the paper (Excluding bonus questions)		70

Practical I

ST – 1P1– Practical on ST–121
(11 sessions 3hr/week)

1. Construction of frequency distributions and contingency tables (pivot tables) and Graphical and Diagrammatic representation of data (Histogram, Bar and Pie) using MS Excel and R
2. Measures of central tendency -1: (AM, GM, HM, Combined mean and weighted means, median, mode and partition values).
3. Measures of central tendency -2: (AM, GM, HM, Combined mean and weighted means, median, mode and partition values) using MS Excel and R
4. Measures of dispersion -1: (Range, Standard deviation, Mean deviation, Quartile deviation & coefficient of variation).
5. Measures of dispersion -2: (Range, Standard deviation, mean deviation, Quartile deviation & coefficient of variation) using MS Excel and R
6. Moments, measures of skewness and kurtosis.
7. Correlation analysis and Regression analysis (simple linear regression)
8. Fitting of power curves of the type $y = a\,x^b$, $y = a\,b^x$, and $y = ae^{bx}$ by the method of least squares using MS Excel and R (Need for studying these models to be explained, such as violation of linearity, etc.,)
9. Computation of probabilities (application of probability, conditional probability and Bayes theorem)
10. Univariate probability distribution - Expectation, mean, variance and distribution function
11. Bivariate probability distribution – marginal and conditional distributions and computation of moments, conditional expectation

Course Outcomes: At the end of the course, the student should

CO1	Discuss and report the key concepts and overview of the subject
CO2	Distinguish different types of data and interpret the same in most attractive and lucid manner.
CO3	Analyzing univariate data and bivariate data.
CO4	Describe the concepts of randomness in variable(s) and their expectations.
CO5	Utilize MS EXCEL and R software to carryout practical assignments andanalysis ofcase studies.

B.Sc. Course in Statistics

Second Semester

ST – 221: Theoretical Probability Distributions

Semester	II
Paper Code	**ST – 221**
Paper Title	**Theoretical Probability Distributions**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

Courseobjectives:

1. To provide students basic knowledge in probability models and their applications.
2. To enable students to understand the importance of sampling and sampling distributions.
3. To help students to understand various methods for data collection.
4. To develop the ability to distinguish between statistical methods and tools.
5. To develop skills in analyzing univariate data using probability models.

Unit -1: Discrete Probability Distributions   20 hrs

Discrete Uniform, Bernoulli, Binomial, Geometric, Negative-binomial, Hyper geometric, and Poisson distributions – definition, examples of variates following these distributions, mean, variance, moments, skewness, kurtosis and m.g.f. Additive property of Binomial, Poisson and Geometric distributions. Lack of memory property of Geometric Distribution and its Interpretation.Inter relationship between Bernoulli, Binomial, Poisson, Negative binomial & Hyper Geometric – statement of conditions only.

Unit- 2: Continuous Probability Distributions   20 hrs

Uniform, Normal distribution and its properties. Cauchy distribution. Chi-square, t and F distributions- Definitions through p.d.f's, their, mean, variance properties and uses. Gamma, Beta and Exponential distributions – definition through p.d.f.s. Mean, variance, moments and m.g.f. Additive property of Exponential and Gamma variates. Lack of memory property of Exponential distribution, its interpretation.

Unit -3: Basics of Sampling   04 hrs

Concepts of population and sample. Need for sampling- complete enumeration vs sample surveys. Probability and Non-probability sampling –meaning, need and illustrations. Methods of drawing random samples-Lottery method and use of random number tables.

Unit- 4: Sampling Distributions: 07 hrs

Definition of a random sample, Basic concepts of Statistic and parameter. Sampling distribution and Standard error. Sampling distribution of sample mean, sample variance, & their independence under normality assumption. Sampling distribution of chi-square, t and F statistic under normality assumption.

Unit -5: Limit Theorems: 04 hrs

Convergence in probability and convergence in distributions (basic results without proofs), Chebychev's inequality (without proof) and its use in approximating probabilities, Statements of Weak law of large numbers for iid random variables – applications, Central limit theorem-Statement (iid with finite variance) and applications.

Skill development exercises/programs/projects/case studies   5 hrs

a. Sample projects/case studies on sampling methods   (2)
b. Sample projects/case studies covering applications of standard probability distributions
    i. Explaining various methods to select appropriate probability model for given data
    ii. Validity of the selected model through chi-square statistic (only as a measure as deviation) and forecasting   (3)

Books for Study:

1. Chandra.T.K.and Chatterjee. D (2001) A First course in Probability. Narosa
2. Hogg.R.V. and Craig.A.T. (1978) Introduction to Mathematical Statistics- 4/e. Macmillan.
3. Mukhopadhyay. P. (1996): Mathematical Statistics. Calcutta Publishing House.
4. Gupta. S.C, and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics. Sultan Chand & Co.
5. NG Das (2008), Statistical Methods combined volume, Tata McGraw-Hill
6. Goon,A.M et.al.: Fundamentals of Statistics Vol II (World Press, Calcutta).
7. Murthy,M.N.(1967): Sampling theory and methods. (Statistical Society, ISI, Calcutta)

References:

1. Bhattacharya and N.L. Johnson (1986): Statistical concepts. John Wiley.
2. Des Raj and Chandok (1998): Sampling Theory, Narosa, New Delhi.
3. Sukhatme,P.V. et.al (1984): Sampling theory of surveys with applications (Indian Society of Agricultural Statistics, New Delhi)
4. Mukhopadhyay. P (1996). Sample surveys. Calcutta Publishing House.
5. Rohatgi. V.K. and A.K. Md. Ehsanes Saleh (2002). An Introduction to Probability theory and Mathematical Statistics. John Wiley. (WSE)
6. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
7. Walpole,R.E and Myers, R.H and Myers.S.L (1998) : Probability and Statistics for Engineers and Scientists. 6th Edition. Prentice Hall, New Jersey.

Resources for skill development exercises:

1. https://www.edx.org/
2. https://www.coursera.org/learn
3. http://www.stattrek.com/
4. https://www.khanacademy.org/
5. http://www.statisticshowto.com/
6. https://www.datacamp.com/
7. https://vincentarelbundock.github.io/Rdatasets/datasets.html
8. https://www.kaggle.com/datasets
9. https://www.khanacademy.org/math/ap-statistics/random-variables-ap/discrete-random-variables/v/discrete-probability-distribution
10. http://weibull.reliasoft.com/

MODEL BLUEPRINT		
Code number:	**ST – 221**	
Title of the paper:	**Theoretical Probability Distributions**	
Unit number	**Number of hrs**	**Total marks**
1	20	36
2	20	36
3	4	7
4	7	13
5	4	7
Total	55	100
Maximum marks for the paper (Excluding bonus question)		70

Practical II

ST – 2P1– Practical on ST – 221
(11 sessions 3hr/week)

1. Applications of Binomial distribution (Computation of probabilities, Fitting of binomial distribution and computation of expected frequencies)
2. Applications of Poisson distribution (Computation of probabilities, Fitting of Poisson distribution and computation of expected frequencies)
3. Applications of Negative binomial distribution (Computation of probabilities, Fitting of Poisson distribution and computation of expected frequencies)
4. Fitting Binomial, Poisson, Geometric, Discrete Uniform Distributions using MS Excel
5. Computations involving Normal probabilities and fitting of normal distribution by area method
6. Computations involving Normal probabilities and fitting of normal distribution by area method and computing expected frequencies, using MS- Excel and R
7. Computation of probabilities based on rectangular and exponential distribution.
8. Computation of probabilities and plotting pmf/pdf, cdfusing MS-Excel and R (Binomial, Poisson, Negative Binomial, Geometric, Uniform, Normal, and Exponential Distributions)
9. Applications of Chebyschev's Inequality, WLLN and Central Limit theorem (Illustrating CLT using MS Excel & R)
10. Drawing random samples and construction of sampling distribution of sample mean and sample variance
11. Drawing random samples and construction of sampling distribution of sample mean and sample variance (using MS Excel and R)

Course Outcomes: At the end of the course, the student should

CO1	Apply discrete and continuous probability distributions to compute probabilities under challenging situations.
CO2	Developing the idea of conducting the sample surveys.
CO3	Usage ofappropriate sampling techniques in a given context.
CO4	Appraise the core theory of the sampling and draw connections to the sampling distribution.
CO5	Critique concepts of sampling distributions and formulate the sampling distributions in applied scenario.
CO6	Sketch real – life problems into frequently used probability models

B.Sc. Course in Statistics

Third Semester

ST – 321: Statistical Inference – I

Semester	III
Paper Code	**ST – 321**
Paper Title	**Statistical Inference I**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

Course objectives:

1. To provide students basic knowledge in estimation theory
2. Introducing traditional estimation methods in statistical theory and to make the students aware of the basic issues in estimation theory
3. Need for studying testing hypotheses and related concepts
4. To train students in formulating null and alternative hypotheses
5. Using SPSS for data analysis

Unit -1: Point Estimation: 18 hrs

Family of distributions, Power Series and single parameter exponential family, Point Estimation - Concepts of estimator and estimate, criteria for a good estimator- Unbiasedness, Consistency, criteria for consistency, Invariance property of consistent estimator, Efficiency, Relative efficiency, minimum variance unbiased estimator, Sufficient Statistic - Statement of Neyman – Factorization theorem, mean square error as a criterion for comparing estimators. (Consider problems on estimation from Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Uniform, Normal and Exponential distributions only)

Unit-2: Methods of Point Estimation: 10 hrs

Maximum likelihood Estimator (MLE), estimating parameters of Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Normal, Exponential, Uniform (continuous) by maximum likelihood method, Properties of MLE, Illustration for non-uniqueness and invariance property of M.L.E
Method of moments, Properties, estimating parameters of Bernoulli, Binomial, Poisson, Geometric, Negative Binomial, Normal, Exponential, Uniform (continuous)

Unit -3: Interval Estimation: 12 hrs

Confidence Interval, Confidence coefficient, Pivotal quantity method of constructing Confidence Intervals, construction of confidence intervals for mean, difference between two means, variance and ratio of variances, proportion, difference between proportions, correlation coefficient

Unit -4: Testing of Hypotheses: 15 hrs

Definition of Statistical hypotheses and types - null and alternative, simple and Composite hypotheses. Type-I and Type-II Errors, size of the test, level of significance, power of the test and power function. Test function, Randomized test and non-randomized test (definition only). Critical region. P-value, its interpretation.

Most Powerful (MP) test. Statement of Neyman – Pearson Lemma and its applications. MP test parameters of Bernoulli and Normal distributions

Skill development exercises/programs/projects/case studies   5 hrs

Introduction to SPSS – downloading and Installing SPSS (trial version),basics of SPSS-worksheets, various types of SPSS files, managing SPSS files (saving, editing, retrieving), defining variables/columns, generating graphs, import and exporting data, tables, analysis using SPSS - descriptive statistics, correlation and regression

Books for Study

1. Freund J.E. (2001): Mathematical Statistics, Prentice Hall of India.
2. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.
3. Hogg R.V. and Tannis E.A. (1988): Probability and Statistical Inference, Collier MacMillan.
4. Hodges J.L and Lehman E.L (1974): Basic Concepts of Probability and Statistics, Holden Day.
5. Mood A.M, Graybill F.A and Boes D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
6. Gupta. S.C. and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics. Sultan Chand & Co.
7. R.H Carver and JG Nash, Doing Data Analysis using SPSS, Brooks/Cole Cengage Learning, 2012
8. An Introduction to IBM SPSS Statistics

References

1. Bhattacharya and Johnson (1986): Statistical Concepts, Wiley Int. Ed.
2. Rohatgi. V.K. and A.K. Md. Ehsanes Saleh (2002). An Introduction to Probability theory and Mathematical Statistics. John Wiley (WSE).
3. Ross S.M: Introduction to Probability and Statistics., John Wiley & Sons
4. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
5. Brian Everitt & Sabin Landau, (2003): A Handbook Statistical Analysis using SPSS, CHAPMAN & HALL/CRC

Resources for skill development exercises:

1. Colin D. Gray & Paul R. Kinnear, IBM SPSS STATISTICS 19, Made Simple, Psychology press
2. Ajai S. Gaur, Sanjaya S. Gaur Statistical Methods for Practice and Research _ A guide to data analysis using SPSS(Second edition), Sage Publications
3. surveyresearch.weebly.com/uploads/2/9/9/8/.../spss_video_tutorials_on_youtube.pdf

4. https://www.youtube.com/watch?v=1VVeR5C5BpM
5. https://in.udacity.com/
6. http://www.stattrek.com/
7. https://www.khanacademy.org/
8. https://www.statisticshowto.com/
9. https://www.datacamp.com/
10. https://vincentarelbundock.github.io/Rdatasets/datasets.html
11. https://www.coursera.org/learn
12. https://www.kaggle.com/datasets
13. https://www.cooldatasets.com/

MODEL BLUEPRINT		
Code number:		**ST – 321**
Title of the paper:		**Statistical Inference I**
Unit number	**Number of hrs**	**Total marks**
1	18	33
2	10	18
3	12	22
4	15	27
Total	55	100
Maximum marks for the paper (Excluding bonus question)		70

Practical III

ST – 3P1– Practical on ST – 321
(11 sessions 3hr/week)

1. Introduction to SPSS – 1: Introduction, creating data file, defining variables/columns, labels. values, sorting of data, construction of frequency distribution and contingency tables, and graphical representation of data
2. Analysis using SPSS -2: Importing different datasets into SPSS from excel, R, Exporting data, and descriptive statistics
3. Analysis using SPSS -3: Correlation and regression, curve fitting, editing output, usage of syntax.
4. Comparison of estimators by plotting mean square error using MS-Excel and R
5. Estimation of parameters by Maximum Likelihood method
6. Estimation of parameters by Method of Moments.
7. Construction of confidence intervals (small & large samples)
8. Construction of confidence intervals using R, SPSS & MS-Excel
9. Evaluation of probabilities of Type-I and Type-II errors and power of tests.
10. Construction of M.P. tests and computation of power.
11. MP test for parameters of Bernoulli distribution & Normal Distributions

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics

Fourth Semester

ST – 421: Statistical Inference – II (Core paper)

Semester	IV
Paper Code	**ST – 421**
Paper Title	**Statistical Inference II**
Number of teaching hrs per week	2
Total number of teaching hrs per semester	30
Number of credits	2

Course objectives:

1. To acquire basic knowledge in parametric tests and limitations of it.
2. To develop skills in formulating and testing various standard hypotheses problems
3. To train students to solve hypotheses problems using calculators and software
4. To help students to understand need for studying non parametric tests

Unit -1: UMP and Likelihood Ratio Tests: 06 hrs

Monotone likelihood ratio (MLR) property. Uniformly most powerful (UMP) test. Statement of the theorem on UMP tests for testing one sided hypotheses for distributions with MLR property. (Only parameter of Bernoulli and mean of Normal Distribution)
Likelihood ratio tests (LRT) and properties of LRT statistic. LRT's for mean of normal distribution (one sample problems).

Unit -2: Tests of Significance: 15 hrs

Large and small sample tests of significance. Tests for single mean, equality of two means, single variance and equality of two variances, tests for proportions, Test for correlation coefficient and regression coefficients (only slope and intercept (t-test)). Fisher's Z-transformation and its applications. Analysis of categorical data- contingency table, various measures of association (Yule's) for two-way data and coefficient of contingency, coefficient of colligation and odds ratio, chi square test for independence of attributes in contingency table, and equality of many proportions using chi square tests, chi square test for goodness of fit

Unit – 3: Non-Parametric tests: 09 hrs

Need for non-parametric tests, Kolmogorov-Smirnov one sample test, Sign test for one sample and two samples, Wilcoxon signed rank test, Median test, Wald Wolfowitz run test, Mann Whitney U test, run test for randomness, test for independence based on Spearman's rank correlation coefficient(small and large samples), Normal probability plot and QQ Plot

Books for Study:

1. Rohatgi. V.K. and A.K. Md. Ehsanes Saleh (2002). An Introduction to Probability theory and Mathematical Statistics. John Wiley (WSE).
2. Hogg R.V. and Tannis E.A. (1988): Probability and Statistical Inference, Collier MacMillan.
3. Mukhopadhyay. P (1996). Applied Statistics. Calcutta Publishing House.
4. Gupta. S.C. and V.K.Kapoor (2001): Fundamentals of Mathematical Statistics. Sultan Chand & Co.
5. Gopal K. Kanji (2006), 100 Statistical tests, 3rd Edition, Sage Publications
6. Purohit S.G. et.al. Statistics using R

References:

1. Dudewicz.E.J. and Mishra.S.N. (1980). Modern Mathematical Statistics. John Wiley.
2. Kale B.K (2005) A First Course on Parametric Inference, Narosa 2nd Edition.
3. Randles R.H and Wolfe DA (1979): Introduction to the Theory of nonparametric Statistics, John Wiley
4. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
5. Venables W.N., Smith D.M. and the R-development core team, An Introduction to R

Resources for skill development exercises:

1. Case studies
2. https://www.statmethods.net/
3. https://www.edx.org/
4. https://www.datacamp.com/
5. http://www.stattrek.com/
6. https://www.khanacademy.org/
7. http://www.statisticshowto.com/
8. https://vincentarelbundock.github.io/Rdatasets/datasets.html
9. https://www.kaggle.com/datasets
10. https://www.cooldatasets.com/

MODEL BLUEPRINT		
Code number:	**ST – 421**	
Title of the paper:	**Statistical Inference II**	
Unit number	**Number of hrs**	**Total marks**
1	6	12
2	15	29
3	9	18
Total	30	59
Maximum marks for the paper (Excluding bonus question)	35	

Practical IV

ST 4P1– Practical on ST – 421
(11 sessions 3hr/week)

1. UMP test and LR test for the mean of normal distribution
2. Tests concerning means (small and large sample)
3. Tests concerning variances (small and large sample)
4. Tests concerning means, variances using MS Excel and R
5. Tests for correlation coefficients and Regression coefficient (slope and intercept)
6. Tests for Independence of attributes and equality of many proportions
7. Analysis of categorical data MS Excel and R, (Construction of pivot tables and pie charts, bar plots, various measures of association using R)
8. Tests for goodness of fit. (uniform, Binomial, Poisson and Normal)
9. Nonparametric tests – 1 (for single and related samples - sign test and Wilcoxon signed rank test, Kolmogorov Smirnov test and one sample runs test)
10. Nonparametric tests – 2 (for two independent samples (Median test, Wilcoxon Mann Whitney - U test, Wald - Wolfowitz's runs test)
11. Various tests for Normality, Histogram, QQ Plot using R

Note: Questions should be designed in order to allow students to compare parametric and non-parametric tests (for same problem)

Note: The excel and R output shall be exported to MS word for writing inference/conclusions

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics

Fourth Semester

STOE – 421:First Course in Statistics (Open Elective)

Semester	IV
Paper Code	**STOE – 421**
Paper Title	**First Course in Statistics**
Number of teaching hours per week	02
Total number of teaching hours per semester	30
Number of credits	02

Course objectives:

1. To acquire basic knowledge in statistics, probability and data collection methods
2. To train the students in computation of descriptive statistics
3. To help students to differentiate between univariate and bivariate data
4. To facilitate students to study relation between two variables through correlation and regression analysis

Unit-1: Basic Statistics: 06 hrs

a. Statistics: Meaning and role as a decision-making science   (1)
b. Basic concepts: Population, Sample, Types of data, Types of scales - nominal, ordinal, ratio and interval. Variables and attributes, discrete and continuous variables.   (2)
c. Representation of data: frequency tables and pivot tables. Histogram, pie chart,   scatter plots
                                                                          (3)

Unit-2: Probability theory: 03 hrs

a. Probability: Random experiment, trial, sample space, events, classical, definition of probability. Properties of probability. Additive law, Multiplicative law and their applications   (3)

Unit-3: Data collection methods: 06 hrs

a. Sample surveys: Sources of data collection, Principal steps in a sample survey, sampling and Non-sampling error, Requisites of a good questionnaire. Drafting of questionnaires and schedules and their pre-test. Pilot surveys.   (3)
b. Basic concepts: Census and Sampling, Types of Sampling, Methods of selecting random sample, Simple random sampling with and without replacement, stratified random sampling, systematic sampling and cluster sampling (only definitions and their applications) with examples   (3)

Unit-4: Univariate Data Analysis: 07 hrs

a. Central Tendency: Measures of Central tendency, Arithmetic mean, median and their applications
   (3)
b. Dispersion: Measures of Dispersion, range, standard deviation and their applications. Relative Measures of Dispersion, coefficient of variation and their applications   (4)

Unit-5: Bivariate Data Analysis: 08 hrs

a. Correlation: measures of correlation, Scatter diagram, Karl Pearson's correlation coefficient, Spearman's Rank correlation coefficient and their properties with their applications   (4)
b. Regression: Simple linear regression analysis, regression coefficients and their properties, Interpretations of slope and intercept. Fitting straight line.   (4)

Books for Study

1. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics Vol.I, World Press, Calcutta.
2. Medhi J (1992): Statistical Methods: An introductory text. New Age.
3. Rajmohan: A Textbook of Statistics Vol -1, Benaka Books
4. Murthy, M.N. (1967): Sampling theory and methods. (Statistical Society, ISI, Calcutta)

References:

1. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1996): Statistics: A Beginner's Text, Vol. I, New Age International(P) Ltd.
2. Medhi J (1992): Statistical Methods: An introductory text. New Age.
3. Anderson T.W. and Sclove S.L (1978) An Introduction to the Statistical Analysis of Data, Houghton Miffin& Co.
4. Sukhatme,P.V. et.al (1984): Sampling theory of surveys with applications (Indian Society of Agricultural Statistics, New Delhi)

MODEL BLUEPRINT		
Code number:		**STOE 421**
Title of the paper:		**First course in Statistics**
Unit number	**Number of hrs**	**Total marks**
1	6	12
2	3	6
3	6	12
4	7	14
5	8	15
Total	30	59
Maximum marks for the paper (Excluding bonus question)		35

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics
Fifth Semester
ST – 5121: Sampling Theory and Design of Experiments

Semester	V
Paper Code	**ST – 5121**
Paper Title	**Sampling Theory and Design of Experiments**
Number of teaching hours per week	03
Total number of teaching hours per semester	40
Number of credits	03

Course objectives:

1. To acquire basic knowledge in various sampling methods
2. To enable students to understand various sampling schemes with their limitations
3. To help students to compare various sampling schemes using standard error criterion
4. To provide basic knowledge in principles of design of experiments and some standard designs with their limitations
5. To help students plan and execute experiments to generate data for comparing treatments
6. To develop skills in analyzing data obtained through experiments using various software

Unit-1: Data collection methods: 04 hrs

Basic definitions - Population, Sample, Sampling unit, Sampling fraction, Sampling Frame, Population Parameter, Estimator, Standard error, Accuracy, Precision, margin of error. Data Collection methods- Census, Sample surveys, Experiments and Observational studies. Methods of collecting primary data, Drafting of questionnaires, schedules and their pre-test. Requisites of a good questionnaire. Pilot surveys. Sampling and Non-sampling errors and simple methods of

controlling them

Unit-2: Simple random sampling and systematic sampling   07 hrs

Sampling with and without replacement. Unbiased estimators of population mean, total and proportions, Derivation of the variances of the estimators of mean and their estimation. Standard errors of the estimators. Construction of confidence intervals for mean and proportions. Determination of sample size.   Linear Systematic sampling - Advantages and limitations, estimation of population means.

Unit-3: Stratified and Cluster sampling   08 hrs

Stratified random sampling-Need for stratification. Unbiased estimators of population mean and total. Derivation of the variance of the estimators and their estimation. Proportional, Optimum and Neyman allocations (without derivation). Comparison of variances with SRSWOR. Estimation of gain in precision due to stratification.
Cluster Sampling – estimation of mean, variance of the estimators of population means and comparisons with other sampling methods

Unit-4: Design and Analysis of Experiment: 15 hrs

Principles of design of experiments, completely randomized, Randomized block and Latin square designs-layout, models, assumptions, derivation of least squares estimates of parameters, hypotheses, test procedures and ANOVA tables. Multiple comparison tests-Least significant difference, Tuckey's test

Unit-5: Factorial Experiments: 06 hrs

2^2 and 2^3 factorial experiments- Main effects and interactions, their best Estimates and orthogonal contrasts. Yates's method of computing factorial effects. Total confounding in a 2^3 factorial experiment- analysis and testing the significance when underlying design is RBD.

Books for Study:

1. Cochran. (1984): Sampling Techniques. (3rd ed.) (Wiley Eastern)
2. Singh. D and Chaudhary,F.S(1986): Theory and Analysis of sampling survey design. (Wiley Eastern).
3. Montgomery, D.C. (2014). Design and Analysis of Experiments, Wiley. New York.
4. Cochran, W.G. and Cox, G. M. (1992). Experimental Designs, John Wiley and Sons, New York.
5. Goon,A.M et.al.: Fundamentals of Statistics Vol II (World Press, Calcutta).
6. Gupta,S.C and V.K. Kapur: Fundamentals of Applied Statistics. (Sultan Chand and Co.)

References:

1. Murthy, M.N. (1967): Sampling theory and methods. (Statistical Society, ISI, Calcutta)
2. Des Raj and Chandok (1998): Sampling Theory, Narosa, New Delhi.
3. Sukhatme,P.V. et.al (1984): Sampling theory of surveys with applications (Indian Society of Agricultural Statistics, New Delhi)
4. Mukhopadhya, P.(2015): Mathematical Statistics, Books and Allied (P) Ltd., Kolkata
5. Joshi, D. D. (1987).Linear Estimation and Design of Experiments, New Age International (P) Limited, New Delhi.
6. Mukhopadhyay. P (1996). Applied Statistics. Calcutta Publishing House.
7. Mukhopadhyay. P (1996). Sample surveys. Calcutta Publishing House.
8. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC

MODEL BLUEPRINT		
Code number:	**ST – 5121**	
Title of the paper:	**Sampling Theory and Design of Experiments**	
Unit number	**Number of hrs**	**Total marks**
1	4	10
2	7	18
3	8	20
4	15	37
5	6	15
Total	40	100
Maximum marks for the paper (Excluding bonus question)		70

Practical V

ST – 5P1– Practical on ST – 5121
(11 sessions 3hr/week)

1. Drawing of random sample under SRSWR and SRSWOR from a given population and estimation of the mean, proportion, total and the standard error of the estimators. Construction of confidence intervals
2. Listing out all possible SRSWR, SRSWOR and systematic samples from a given population and computation of variance of the estimator and its comparison with that of SRSWOR and stratified sampling.
3. Stratified Random Sampling - (Estimation of the mean, total and the standard error of the estimators under stratified random sampling & allocation problems under stratified random sampling, comparison of the precisions of the estimators under with other sampling methods)
4. Cluster Sampling – (Estimation of the mean, total and the standard error of the estimators under cluster random sampling)
5. Completely Randomized Design & Analysis of one-way classification data
6. Randomized Block Design & Analysis of two-way classification data
7. Analysis of one way and two-way classification data using MS Excel and R
8. Latin Square Design
9. Multiple comparison tests- least significant difference, Tuckey's test
10. Analysis of 2^2 and 2^3 factorial experiment using RBD layout.
11. Analysis of 2^3 factorial experiment using RBD layout. (Complete confounding)

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics

Fifth Semester
ST – 5221: Statistical Methods for Quality Management

Semester	V
Paper Code	**ST – 5221**
Paper Title	**Statistical methods for Quality Management**
Number of teaching hrs per week	3
Total number of teaching hrs per semester	40
Number of credits	3

Course objectives:

1. To make students to understand importance of quality and need for controlling quality
2. To facilitate students to acquire basic knowledge about seven quality control tools
3. To develop the ability to distinguish between process control and product control
4. To help students in constructing various control charts using software
5. To enable students to understand importance of quality standards and lot acceptance sampling

Unit-1: Basics of Statistical Quality Control: 08 hrs

Introduction-quality, quality control, Quality assurance, quality costs. Seven QC tools. Chance and assignable causes of variation. Introduction to quality standards –BIS and ISO, Six-sigma and Total Quality Management. Statistical Quality Control (SQC) -. Aims and objectives, Process control and product control. Control charts and basis for its construction, Probability and k sigma limits, action and warning limits. Rational subgroups

Unit-2: Control Charts for variables: 06 hrs

Derivation of control limits, construction and interpretation of mean, range and standard deviation

charts. Revised control charts. Criteria for detecting lack of control, OC and ARL for mean and range charts

Unit-3: Control Charts for attributes: 05 hrs

Need for control charts for attributes, derivation of control limits, basis, construction and interpretation of np-chart, p-chart, stabilized p-chart, c-chart, u-chart and their applications.

Unit-4: Process Capability: 04 hrs

Natural tolerance limits and specification limits. Process capability study-process capability and Process capability ratio Cp, Cpk, Cpm

Unit- 5: Lot Acceptance Sampling: 11 hrs

Acceptance sampling-Introduction. Sampling inspection, 100 percent inspection and Rectifying inspection. AQL, LTPD, Producer's risk and consumer's risk, Acceptance Sampling plans – single and double sampling plans by attributes. Derivation of O.C, A.O.Q, A.S.N and A.T.I, functions for single and double sampling plans. Construction of single sampling plans by attributes given AQL, LTPD, producer's risk, consumer's risk.

Unit – 6: Sequential Probability Ratio Test: 06 hrs

Sequential Probability Ratio Test; concept and operational definition. Determination of stopping bounds A and B, OC and ASN functions of SPRT for testing the mean of a normal distribution with known variance. Statement of the optimal property of SPRT.

Books for Study:

1. Grant, E.L and Leavenworth,R.S (1988): Statistical Quality control. 6th edition, McGrawHill.
2. Gupta,R.C: Statistical Quality control. (Khanna Pub. Co.)
3. Montgomery,D.C (1985): Introduction to Statistical Quality control. (Wiley Int. Edn.)
4. Goon,A.M et.al.: Fundamentals of Statistics Vol II (World Press, Calcutta
5. Gupta,S.C and V.K. Kapur: Fundamentals of Applied Statistics. (Sultan Chand and Co.)

References:

1. John, S.Oakland and Followell,R.F (1990): Statistical Process Control. (East West Press, India)
2. Wetherill,G.B and D.W.Bfown: Statistical Process Control theory and practice. (Chapman and Hall)
3. Mahajan,M (2001): Statistical Quality Control. Dhanpat Rai & Co. (P) Ltd.
4. Donne,C.S. (1997): Quality. Prentice Hall.
5. Sinha S.K. and Kale B.K.(1980) Life testing and Reliability (New age)
6. Duncan A.J (1974): Quality Control and Industrial Statistics, Taraporewala and Sons.
7. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
8. Issa Bass (2007), Six Sigma Statistics with EXCEL and MINITAB, McGraw Hill
9. Ruth K. Meyer, David D. Krueger, (1998), A Minitab Guide to Statistics, Prentice Hall,
10. https://cran.r-project.org/web/packages/qcc/qcc.pdf

MODEL BLUEPRINT		
Code number:	**ST – 5221**	
Title of the paper	**Statistical Methods for Quality Management**	
Unit number	**Number of hrs**	**Total marks**
1	8	20
2	6	15
3	5	13
4	4	10
5	11	28
6	6	15
Total	40	100
Maximum marks for the paper (Excluding bonus question)		70

ST – 5P2– Practical on ST – 5221

(11 sessions 3hr/week)

1. $\overline{X}$ – R charts. (Standard values known and unknown)
2. $\overline{X}$ – S charts. (Standard values known and unknown)
3. np and p charts. (Standard values known and unknown).
4. C and U charts. (Standard values known and unknown).
5. $\overline{X}$ – R and $\overline{X}$ – s charts (using R and/or Minitab)
6. np, p, C and U charts (using R and/or Minitab)
7. OC and ARL curves for $\overline{X}$ and R charts.
8. Construction of single sampling plans by attributes
9. Drawing OC, AOQ, ASN, and ATI curves for single sampling plans by attributes.
10. Drawing OC, AOQ, ASN, and ATI curves for double sampling plans by attributes.
11. Sequential Probability Ratio Test (SPRT)

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics

Sixth Semester

ST – 6121: Applied Statistics

Semester	VI
Paper Code	**ST – 6121**
Paper Title	**Applied Statistics**
Number of teaching hrs per week	3
Total number of teaching hrs per semester	40
Number of credits	3

Course objectives:

1. To expose the students to the applications of statistics in various fields
2. To acquire basic knowledge in official statistics, time series analysis, simulation and regression analysis
3. To provide the students with discussion on some of the key issues in regression
4. To develop skills in performing regression analysis and model validation using various software
5. To enable students to use various statistics generated through regression analysis to measure and compare performances of different regression models

Unit-1: Applied Regression Analysis: 18 hrs

Multivariate Data, Correlation - Different types of correlation, Simple, Multiple and Partial Correlation and their measures (in three variables).
Introduction to Multiple Linear Regression, Model, Assumptions, Estimation of regression coefficients (only up to three variables), Model fitting, residuals, Coefficient of determination, t-test for significance of regression coefficient, F-test for significance of model, Different methods of variable selections – forward, backward, step-wise (only explanation),   Model Adequacy – Residual Analysis, tests for normality – QQ Plot, Introduction to Heteroscedasticity, Multicollinearity and Autocorrelation, measures of identifying above situations and remedial measures. Introduction to logistic regression

Unit-2: Time Series Analysis: 05 hrs

Components of Time series. Additive and multiplicative models. Measurement of trend by moving averages and by least squares.Construction of seasonal indices by simple averages and ratio to moving averages.

Unit-3: Official Statistics   04 hrs

Various agencies responsible for the data collection in India – MOSPI, DES, C.S.O, N.S.S.O, Office of Registrar General, their main functions and publications. Estimation of National Income: Product approach, Income approach and Expenditure approach. Measuring inequality in incomes: Lorenz curve, Gini-coefficient, Theil's measure.

Unit-4: Application of Statistics in Medical Research: 06 hrs

Introduction to clinical trials, phases in clinical trials. Therapeutic trails, Prophylactic trails. Observational studies-Cross sectional studies, Prospective studies, retrospective studies, randomized control studies, odds ratio and its confidence interval, Measurement of potential impact. Diagnostic efficacy- Application of Bayes' theorem. Sensitivity specificity, False negative rate, False positive rate, Predictive value positive predictive value negative, Receiver operating characteristic (ROC) curve.

Unit - 5: Simulation: 07 hrs

Introduction to Simulation, Monte Carlo method, Generation of random observations from Uniform, Exponential, Normal, Binomial, Poisson distributions, simple illustrations
Applications of simulations in business and various industries

Books for Study:

1. Goon, A.M et.al.: Fundamentals of Statistics Vol II (World Press, Calcutta).
2. Gupta,S.C and V.K. Kapur: Fundamentals of Applied Statistics. (Sultan Chand and Co.)
3. Sundar Rao P.S.S. and Richard J, Introduction to Biostatistics and research Methods (PHI 2006)
4. Clinical Trials "A practical Approach" by Stuart J. Pocock
5. Guide to Current Indian Official Statistics: Central Statistical Organization, Govt. of India, New Delhi.
6. Tukey J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.
7. Frederick Mosteller, John W. Tukey: (1977) Data Analysis and Regression: A Second Course in Statistics, Addison-Wesley Publishing Co.
8. Sen, A. (1997). Poverty and Inequality, Stanford University Press, USA.
9. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining(2012), An Introduction to Linear Regression Analysis, John Wiley (WSE).
10. John Fox (2015), Applied Regression Analysis, Generalized Linear Models, 3rd Edition, SAGE Publications
11. Ross S.M (2003) Introduction to Probability Model, 5/e

References:

1. Mukhopadhyay, P. (2015). Applied Statistics, Books and Allied Pvt Ltd., Kolkata.
2. Clinical Trials -A practical Guide to Design, Analysis and Reporting- by Duolao Wang, AmeetBakhai
3. Chakravarti I.E., Laha and Roy: Handbook of methods of Applied Statistics.
4. Asthana and Shrivastava: Applied Statistics of India.
5. Saluja M.P, Indian Official statistical Systems, Statistical Publishing Society,Calcutta.
6. CSO (1980). National Accounts Statistics – Sources and Health.
7. John Verzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC
8. Daniel B. Wright and Kamala London (2009), Modern Regression Techniques Using R A Practical Guide for Students and Researchers, SAGE Publications
9. Montgomery, D.C. and Runger, G.C. (2013). Applied Statistics and Probability for Engineers, Wiley India, New Delhi
10. UNESCO: Principles for Vital Statistics Systems. Series M -12.

MODEL BLUEPRINT		
Code number:		ST 6121
Title of the paper:		**Applied Statistics**
Unit number	**Number of hrs**	**Total marks**
1	18	45
2	5	12
3	4	10
4	6	15
5	7	18
Total	40	100
Maximum marks for the paper (Excluding bonus question)		70

Practical VII

ST – 6P1– Practical on ST – 6121
(11 sessions 3hr/week)

1. Analysis of Bivariate and Trivariate Data (mean, variance, correlation - Simple, Partial, Multiple)
2. Applied Regression – 1 (Fitting Regression model for Bivariate and Trivariate Data)
3. Applied Regression – 2 (Fitting Regression model for Multivariate Data) (using MS-Excel and R)
4. Applied Regression – 3 (Model Adequacy-Residual Analysis, t-test, F-test, variable selection) (Using MS-Excel and R)
5. Applied Regression – 4 (Heteroscedasticity, Multicollinearity and Autocorrelation) (Using MS-Excel and R)
6. Determination of secular trend by moving averages and least squares methods.
7. Measurement of seasonal variation by simple averages and ratio to moving averages.
8. Official Statistics: computation of national income and income inequalities
9. Clinical statistics
10. Simulation – 1: Generating random observations from standard probability models (Manual and using MS-Excel & R)
11. Simulation – 2: Applications of simulation in business (using R)

Note: The excel and R output shall be exported to MS word for writing inference.

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

B.Sc. Course in Statistics

Sixth Semester

ST – 6217: Operations Research

Semester	VI
Paper Code	**ST – 6221**
Paper Title	**Operations Research**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

Course objectives:

1. To enable students to understand the importance of operations research
2. To help students to understand various optimization problems
3. Introducing traditional methods of solving optimization problems

Unit-1: Introduction to O.R and L.P.P: 09 hrs

Definition and scope of operations research (OR). Modeling and solution. Linear programming problem (L.P.P) – Definition, Standard and canonical forms. Formulation of LPP. Basic solutions, Degenerate and non-degenerate solution. Fundamental theorem of LPP. Graphical solution and Simplex algorithm for solving an LPP, Criteria for unbounded, multiple and infeasible solutions. Artificial variable, Charnes' Big- M Method.

Unit-2: Transportation problem and Assignment problem: 07 hrs

Transportation problem: Mathematical formulation, finding an initial basic feasible solution by North West corner rule, and Vogel's method. Test for optimality by u-v method, Transportation algorithm (MODI method). Problem of Degenerate solution and its resolution
Assignment problem: Mathematical formulation and Hungarian algorithm, Job sequencing, optimal sequence of N jobs on two and three machines

Unit-3: Statistical Decision Theory and Game theory: 06 hrs

Statistical decision problem and essential elements. Decision making under uncertainty and risk. Game theory-Basic concepts. Two-person zero sum game, Pure and mixed strategies. Maximin–Minimax principle, Games with saddle point. Principle of dominance. Games without Saddle point. -mixed strategies, Determination of optimum solution for (2x2) game. Solution by graphical method for (2xn) and (mx2) games.

Unit-4: PERT and CPM: 06 hrs

Basic elements of Network, Drawing of project network. Project planning with CPM and PERT. Critical path calculation. Critical path, slack time, floats. PERT three estimate approach. Calculation of probabilities of completing a Project within a specified period.

Unit-5: Inventory Theory: 07 hrs

Description of an inventory system, Inventory costs. Demand, lead time and reorder level. Inventory models. EOQ model with and without shortages, P – system and Q – system of Inventory

Unit-6: Queuing theory: 05 hrs

Basic elements, description of a queuing system and measures of effectiveness. statement of steady state solution of M/M/1 queuing system. Waiting time distributions. Little's formula derivation of expressions for Queue length, and system size(length) and waiting times. Description of M/M/C queuing system.

Books for Study

1. Kanthiswarop, Manmohan and P.K. Gupta (2003) Operations Research. Sultan Chand & Co.
2. S D Sharma, Operations Research: Theory and Applications, (2009), Fourth Edition,
3. Churchman, C.W, Ackoff,R.L and Arnoff, E.L. (1957): Introduction to Operations Research. John Wiley.
4. S. D. Sharma, R. K. Malhotra, Operations Management,
5. Shenoy, G.V., Srivastava, U.K and Sharma, S.C: Operations Research for management. New Age Publications.
6. Kalavathy S - Operations Research (Vikas Publishers)

References:

1. Mustafi, C.K. Operations Research methods and practice. New Age. Pub.
2. Mital, K.V. Optimization method. New Age Pub.
3. Narag.A.S. Linear Programming and Decision making. Sultan Chand & Co.
4. Kapoor,V.K. Operations Research. Sultan Chand & Co.
5. N. D. Vohra: Quantitative Techniques in Management (Tata McGraw Hill)
6. JohnVerzani (2005): Using R for Introductory Statistics, CHAPMAN & HALL/CRC

MODEL BLUEPRINT		
Code number:		**ST 6221**
Title of the paper:		**Operations Research**
Unit number	**Number of hrs**	**Total marks**
1	9	23
2	7	18
3	6	15
4	6	15
5	7	18
6	5	13
Total	40	100

Maximum marks for the paper (Excluding bonus question)	70

Practical VIII

ST – 6P2– Practical on ST – 6221
(11 sessions 3hr/week)

1. Formulation of Linear programming problem (L.P.P)- Graphical solution
2. Solution of L.P.P -using simplex algorithm.
3. Solution of L.P.P -using Big M Method
4. Transportation Problem
5. Assignment Problems
6. Job Sequencing
7. Decision theory problems.
8. Game theory problems.
9. PERT and CPM
10. Queuing Problems
11. Inventory problems

Course Outcomes: At the end of the course, the student should

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	