FAROOK COLLEGE (AUTONOMOUS)

Farook College PO, Kozhikode-673632

U.G Programme in Statistics

Under

Choice Based Credit Semester System

SYLLABUS

Core, Complementary & Open Courses

(2022 Admission Onwards)

Prepared By:

Board of Studies in Statistics

Farook College (Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the bona fide copies of the syllabus of Core Courses offered to B.Sc. Statistics programme and Complementary and Open Courses offered by the Department of Statistics to be effective from 2022 admission onwards.

Date: Principal

Place: Farook College

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PROGRAM STRUCTURE OF B.Sc. STATISTICS PROGRAMME

FCCBCSS- UG 2022 (2022 admission onwards)

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<tr><td rowspan="2">Total</td><td>22 credits (550 marks)</td><td>16 credits (400 marks)</td><td>55 credits (1350 marks)</td><td>3 credits (75 marks)</td><td>12 credits (300 marks)</td><td>12 credits (300 marks)</td><td>120 credits (2975 marks)</td></tr>
<tr><td colspan="2">38 credits (950 marks)</td><td colspan="2">58 credits</td><td colspan="2">24 credits(600 marks)</td><td>120 credits (3000 marks)</td><td>16 credits (400 marks)</td><td>4 credits (-- marks)</td></tr>
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*Practical (5 credits) **Project(2 credits)

CREDIT AND MARK DISTRIBUTION OF B. Sc. STATISTICS PROGRAMME

FCCBCSS- UG 2022 (2022 admission onwards)

Semester	Paper Code	Course	Credit	Instructional Hours per Week	Duration of Exam	Total Marks: (Internal and External in the ratio 1:4)
I	--- A01	Common Course: English	3	4	2	75
	--- A02	Common Course: English	3	5	2	75
	--- A07	Common Course: Additional Language	4	4	2.5	100
	BST1B01	Core Course: Official Statistics and Probability	4	4	2.5	100
	BMT1C01	Complementary Course: (Mathematics) Mathematics-1	3	4	2	75
	BAS1C01	Complementary Course: (Actuarial Science) : Financial Mathematics	3	4	2	75
		Total	**20**			**500**
II	--- A03	Common Course: English	4	4	2.5	100
	--- A04	Common Course: English	4	5	2.5	100
	--- A08	Common Course: Additional Language	4	4	2.5	100
	BST2B02	Core Course: Bivariate Random Variables and Probability Distributions	4	4	2.5	100
	BMT2C02	Complementary Course: (Mathematics) Mathematics-2	3	4	2	75
	BAS2C02	Complementary Course: (Actuarial Science) : Life Contingencies	3	4	2	75
		Total	**22**			**550**
III	--- A05	Common Course: English	4	5	2.5	100
	--- A09	Common Course: Additional Language	4	5	2.5	100
	BST3B03	Core Course: Statistical Estimation	4	5	2.5	100
	BMT3C03	Complementary Course: (Mathematics) Mathematics-3	3	5	2	75
	BAS3C03	Complementary Course: (Actuarial Science) Life Contingencies and Principles of Insurance	3	5	2	75
		Total	**18**			**450**
IV	--- A06	Common Course: English	4	5	2.5	100
	--- A10	Common Course: Additional Language	4	5	2.5	100

	BST4B04	Core Course: Testing of Hypothesis	4	5	2.5	100
	BMT4C04	Complementary Course: (Mathematics) Mathematics-4	3	5	2	75
	BAS4C04	Complementary Course: (Actuarial Science) Probability Models and Risk Theory	3	5	2	75
		Total	**18**			**450**
V	BST5B05	Mathematical Methods in Statistics	4	5	2.5	100
	BST5B06	Sample Surveys	5	5	2.5	100
	BST5B07	Linear Regression Analysis	4	5	2.5	100
	BST5B08L	Statistical Computing	5	5	2.5	100
	BST5D01 BST5D02 BST5D03	Open Course: Economic Statistics Quality Control Basic Statistics	3	3	2	75
		Project Work	---	2	-	
		Total	**21**			**475**
VI	BST6B09	Time Series and Index Numbers	4	5	2.5	100
	BST6B10	Design of Experiments	5	5	2.5	100
	BST6B11	Population Studies, Actuarial Science and Vital Statistics	4	5	2.5	100
	BST6B12	Operations Research and Statistical Quality Control	4	5	2.5	100
	BST6B13P	Project Work	2	2	--	75
	BST6E01 BST6E02 BST6E03	Probability Models and Risk Theory Stochastic Processes Reliability Theory	2	3	2	75
		Total	**21**			**550**
	English		**22**			**550**
	Additional Language		**16**			**400**
	Mathematics(Complementary course-1)		**12**			**300**
	Actuarial Science(Complementary course-1I)		**12**			**300**
	Open Course		**3**			**75**
	Statistics(Core Courses)		**55**			**1350**
	Total		**120**			**2975**

B. Sc. STATISTICS PROGRAMME
FCCBCSS- UG 2022 (2022 admission onwards)
Structure and Syllabi of Core Courses
(With effect from the academic year 2022-2023 onwards)

Programme Duration: **Three years,** divided into **six semesters** of not less than 90 working days each

Core and Elective Courses

Semester	Paper Code	Paper title	Credit	Instructional Hours per Week	Duration of Exam
I	BST1B01	OFFICIAL STATISTICS AND PROBABILITY	4	4	2.5
II	BST2B02	BIVARIATE RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS	4	4	2.5
III	BST3B03	STATISTICAL ESTIMATION	4	5	2.5
IV	BST4B04	TESTING OF HYPOTHESIS	4	5	2.5
V	BST5B05	MATHEMATICAL METHODS IN STATISTICS	4	5	2.5
	BST5B06	SAMPLE SURVEYS	5	5	2.5
	BST5B07	LINEAR REGRESSION ANALYSIS	4	5	2.5
	BST5B08L	STATISTICAL COMPUTING	5	5	3
	BST5D 01 BST5D 02 BST5D 03	ECONOMIC STATISTICS QUALITY CONTROL BASIC STATISTICS	3	3	2
		PROJECT WORK	---	2	---
VI	BST6B09	TIME SERIES AND INDEX NUMBERS	4	5	2.5
	BST6B10	DESIGN OF EXPERIMENTS	5	5	2.5
	BST6B11	POPULATION STUDIES, ACTUARIAL SCIENCE AND VITAL STATISTICS	4	5	2.5
	BST6B12	OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL	4	5	2.5
	BST6B13P	PROJECT WORK	2	2	--
	BST6E01 BST6E02 BST6E03	PROBABILITY MODELS AND RISK THEORY STOCHASTIC PROCESSES RELIABILITY THEORY	2	3	2

COMPLEMENTARY COURSES OF B.Sc. STATISTICS

Complementary 1: Mathematics

Complementary 2: Actuarial Science

EVALUATION AND GRADING

Evaluation: The evaluation scheme for each course shall contain two parts:

1) Internal assessment 2) External Evaluation

20% weight shall be given to the internal assessment. The remaining 80% weight shall be for the external evaluation.

(A) THEORY AND PRACTICAL:

Internal Evaluation of Theory Courses

The internal assessment shall be based on a predetermined transparent system involving written tests, Class room participation based on attendance in respect of theory courses and lab involvement/records attendance in respect of Practical Courses.

Theory: Components with percentage of marks of Internal Evaluation of Theory Courses are- Test paper 40%, Assignment 20%, Seminar 20% and Class room participation based on attendance 20%.

For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the mark of the best one should be taken.

Split up of of marks for Test paper (40% of total)

Range of Marks in test paper	Out of 8 (Maximum internal marks is 20)	Out of 6 (Maximum internal marks is 15)
Less than 35%	1	1
35% - 45%	2	2
45% - 55%	3	3
55% - 65%	4	4
65% -85%	6	5
85% -100%	8	6

Split up of of marks for Class Room Participation (20% of total)

Range of CRP	Out of 4 (Maximum internal marks is 20)	Out of 3 (Maximum internal marks is 15)
50% ≤ CRP < 75%	1	1
75% ≤ CRP < 85%	2	2
85 % and above	4	3

Internal Evaluation of Practical Courses: For practical courses - Record 60% and lab involvement 40% as far as internal is concerned. (If a fraction appears in internal marks, nearest whole number is to be taken)

External Evaluation of Theory Courses

External evaluation carries 80% of marks. All question papers shall be set by the College. The external question papers may be of uniform pattern with 80/60 marks. The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks.

Pattern of Question Papers

Question paper type 1 (for 80 marks) Scheme of Examinations:

The external QP with 80 marks and internal examination is of 20 marks. Duration of each external examination is 2.5 hours. The pattern of External Examination is as given below. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Section A

Short answer type carries 2 marks each - 15 questions	Ceiling - 25

Section B

Paragraph/ Problem type carries 5 marks each - 8 questions	Ceiling - 35

Section C

Essay type carries 10 marks (2 out of 4)	2×10=20

Question paper type 2 (for 60 marks) Scheme of Examinations:

The external QP with 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

Section A

Short answer type carries 2 marks each - 12 questions	Ceiling - 20

Section B

Paragraph/ Problem type carries 5 marks each - 7 questions	Ceiling - 30

Section C

Essay type carries 10 marks (1 out of 2)	1×10 =10

Questions in each part should be equally distributed among the various modules of the syllabus.

External Evaluation of Practical Courses

External evaluation carries 80% of marks. The external examination in practical courses shall be conducted by two examiners – one internal and an external. The Board of examiners (BoE) shall decide the pattern of question paper. The duration of the external examination is 3 hours. The external examination at each center shall be conducted and evaluated on the same day jointly by two examiners – one external and one internal. Evaluation shall be done by

assessing each candidate on the scientific and experimental skills, the efficiency of the algorithm/program implemented, the presentation and interpretation of the results.

(A) PROJECT EVALUATION: (Internal and External)

Evaluation of the Project Report shall be done under Mark System. The evaluation of the project will be done at two stages: Internal Assessment (supervising teachers will assess the project and award internal Marks) and External evaluation (external examiner appointed by the College.). Grade for the project will be awarded to candidates, combining the internal and external marks. The internal to external components is to be taken in the ratio 1:4. Assessment of different components may be taken as below.

Internal (20% of total)	**External (80% of Total)**	
Components	**Percentage of internal marks**	**Components**
Originality	20 %	Relevance of the Topic, Statement of Objectives
Methodology	20 %	Reference/ Bibliography, Presentation, quality of Analysis/ Use of Statistical Tools.
Scheme/Organization of Report	30 %	Findings and recommendations
Viva – Voce	30 %	Viva – Voce

GRADING:

Indirect grading System based on a 10-point scale is used to evaluate the performance of students. Each course is evaluated by assigning marks with a letter grade (O, A+, A, B+, B, C, P, F, I or Ab) to that course by the method of indirect grading. An aggregate of P grade (after external and internal put together) is required in each course for a pass and also for awarding a degree (A minimum of 20% marks in external evaluation is needed for a pass in a course. But no separate pass minimum is needed for internal evaluation).

Indirect Grading System in 10 -point scale is as below:

Ten Point Indirect Grading System

Percentage of Marks (Both Internal &External put together)	Grade	Interpretation	Grade point Average (G)	Range of grade points	Class
95 and above	O	Outstanding	10	9.5 -10	First Class with Distinction
85 to below 95	A+	Excellent	9	8.5 -9.49	
75 to below 85	A	Very good	8	7.5 -8.49	
65 to below 75	B+	Good	7	6.5 -7.49	First Class
55 to below 65	B	Satisfactory	6	5.5 -6.49	
45 to below 55	C	Average	5	4.5 -5.49	Second Class
35 to below 45	P	Pass	4	3.5 -4.49	Third Class
Below 35	F	Failure	0	0	Fail
Incomplete	I	Incomplete	0	0	Fail
Absent	Ab	Absent	0	0	Fail

PROGRAMME OUTCOMES

On completion of a graduate program in Science, the students will be able to:

PO1: Understand the basic concepts, fundamental principles, and scientific theories associated with various scientific phenomena and internalize their relevance in everyday life.
PO2: Demonstrate and apply fundamental knowledge in the disciplines of Biological/ Physical/Mathematical/computational Sciences and their application in research and industry.
PO3: Explore inter-disciplinary areas in the field of basic and applied sciences.
PO4: Conceive the methodology of sciences starting from observation, evidence-based knowledge acquisition, deduction, logical inferences and induction leading to knowledge production.
PO5: Develop scientific temper and apply scientific knowledge in various fields for the betterment of individuals and society as a whole.
PO6: Understand and analyze the problems in the local and global sphere and use the basic knowledge in science to solve real-life situations.
PO7: Acquire the skills in handling scientific instruments, performing laboratory experiments, taking measurements and analyzing the data scientifically.
PO8: Critically evaluate and discuss scientific literature and key methodologies with regard to validity, reliability, and applicability, within the biological and physical sciences.
PO9: Understand the philosophical foundations of science and reciprocal influence of other disciplines such as Humanities, Arts, Social sciences, etc. in the evolution of new scientific theories and inventions.
PO10: Critically evaluate the potential and impact of scientific innovations on the environment and find a sustainable solution to issues pertaining to the environment, public health, and agriculture.
PO11: Develop laboratory skills, computational skills, qualitative and quantitative data handling skills so that students apply their scientific knowledge in real-life situations.
PO12: Acquire Practical, technical, and professional skills to qualify for a broad range of positions in research, industry, consultancy, education and social development.

PROGRAMME SPECIFIC OUTCOMES

PSO1: Acquire the ability to learn and deal with data and arrive at conclusions with conceptual clarity and validity.

PSO2: Apply the concepts of probability, statistics and related fields to the real life situations.

PSO3: Develop skill in programing languages R/Python.

PSO4: Prepare them for pursuing higher studies in Statistics and related fields or achieve a professional life after graduation.

SYLLABUS
DETAILED SYLLABI OF CORE COURSES

BST1B01: OFFICIAL STATISTICS AND PROBABILITY

Contact Hours per week: 4
Number of credits: 4
Number of Contact Hours: 72
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Describe the functions of MOSPI, CSO, NSSO, DES etc.
CO 2: Recall the fundamental concepts of statistics.
CO 3: Demonstrate various types of data and their graphical representation.
CO 4: Explain the measures of location and dispersion.
CO 5: Compute coefficients of correlation.
CO 6: Construct linear and nonlinear curves.
CO 7: Know the basic concepts of probability theory.
CO 8: Solve problems in probability theory.

Module 1: Statistical organizations in India-MOSPI; CSO, NSSO, DES; Roles functions and activities of CSO, NSSO and DES, Kerala Statistical Commission and National Statistical Commission. Origin of Statistics, functions, limitations, Statistical survey; quantitative and qualitative data, nominal, ordinal and time-series data, discrete and continuous data, collection and presentation of data by tables and diagrams, frequency distributions for discrete and continuous data, cumulative frequency distributions, graphical representation of a frequency distribution by histogram and frequency polygon, ogives

15 hours

Module 2: Measures of central tendency – Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Mode, Percentiles, Quartiles; Measures of dispersion- Variance, Standard deviation, Mean deviation, Quartile deviation, Coefficient of variation; moments, factorial moments, Skewness, Kurtosis.

20 hours

Module 3: Fitting of straight line, parabola, exponential, polynomial, (least square method), correlation-Karl Pearson's Correlation coefficient, Rank Correlation-Spearman's rank correlation co-efficient, Partial and Multiple Correlation (Definition only), Scatter diagram, regression, two regression lines, regression coefficients. 12 hours

Module 4: Experiment, Non- random and Random experiments, Sample space, event, classical definition of probability, statistical regularity, field, sigma field, axiomatic definition of probability and simple properties, addition theorem (two and three events), conditional probability of two events, multiplication theorem,independence of events-pair wise and mutual, Bayes theorem.

Practicals based on statistical analysis of data related to medical/biological/agricultural fields using R software which include the statistical tools; measures of central tendency, measures of dispersion, skewness and kurtosis, correlation and regression 25 hours

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi
5. Statistical system in India (CSO), 1995.

BST2B02: BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS

Contact Hours per week: 4
Number of credits: 4
Number of Contact Hours: 72
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Define a random variable.
CO 2: Express the features of probability mass and probability density functions.
CO 3: Define discrete and continuous distributions.
CO 4: Solve the problems related with theoretical discrete and continuous probability distributions.
CO 5: Learn the concepts of Chebychev's inequality, Convergence in probability, WLLN and Centrallimit theorem (CLT) for i.i.d. case.

Module 1: Random variables-discrete and continuous, probability mass function (pmf) and probability densityfunction (pdf)-properties and examples, cumulative distribution function and its properties, change of variable (univariate case). 10 hours

Module 2: Bivariate random variable, joint pmf and joint pdf, marginal and conditional probability, independence of random variables. Mathematical expectations-definition, raw and central moments (definition and relationships), moment generating function and properties, characteristic function (definition and basic properties). Bivariate case-conditional mean and variance, covariance, Karl Pearson Correlation coefficient, independence of random variables based on expectation.

25 hours **Module 3:** Standard discrete distributions-Bernoulli, Binomial, Poisson, Geometric, negative binomial, Hyper geometric (definition, properties and applications), Uniform. Continuous type-Uniform, exponential, gamma, Beta, Normal (definition, properties and applications), Lognormal, Pareto and Cauchy (Definition only).

20 hours

Module 4: Limit Theorems: Chebychev's inequality, Convergence in probability, Convergence in distribution(definition and example only), weak law of large numbers (iid case), Bernoulli's law of large numbers). Central limit theorem (Lindberg- Levy-iid case).
Practicals based on probability models of biological data using R software which include the statistical tools ; Binomial distribution, Poisson distribution, Normal distribution, Log Normal distribution etc.

17 hours

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. S.C.Gupta and V. K. kapoor Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

BST3B03: STATISTICAL ESTIMATION

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Define the terms parameter, statistic and standard error.
CO 2: Develop the probability distributions of sampling distributions and explain the properties..
CO 3: Identify the desirable properties of a good estimator.
CO 4: Compute the parameter estimates using the various methods.
CO 5: Construct the confidence intervals for the mean, variance and ratio of variances. .

Module 1: Sampling distributions: Parameter, Statistic, standard error, Sampling from normal distribution: distribution of sample mean, sample variance, chi-square, students t distribution, and F distribution (definition,derivation, property and relationships).

20 hours

Module 2: Estimation of Parameter: Point Estimation. Desirable properties of a good estimator, unbiasedness,consistency, sufficiency, Fisher - Neyman factorization theorem (Statement and application only), efficiency, Cramer - Rao inequality and its applications.

25 hours**Module 3**: Methods of Estimation - method of maximum likelihood, method of moments, Bayesian estimationmethod.

20 hours.

Module 4; Interval Estimation: Large sample confidence interval for mean, equality of means, equality of proportions. Derivation of exact confidence intervals for means, variance and ratio of variances based on Normal, t, chi square distribution and F distribution.

Practicals based on estimation of parameters required for statistical analysis of data related to medical/biological/agricultural fields using R software which include the statistical tools ; sampling distributions (t, F, chi square etc.) and parameter estimation (Point and interval), Bayesian estimation

25 hours

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

BST4B04: TESTING OF HYPOTHESIS

Contact Hours per week:
5Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20
MarksDuration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Explain the basic concepts of hypothesis testing.
CO 2: Identify suitable tests of significance to test a given hypothesis -large sample test/small sample test for testing different parameters.
CO 3: Illustrate the important nonparametric tests and their applications.

Module 1: Testing of Hypotheses; concept of testing hypotheses, simple and composite hypotheses, null and alternative hypotheses, type I and type II errors, critical region, level of significance, power of test. Most powerful tests uniformly most powerful test, Neyman Pearson Lemma (statement only). Sequential sampling and SPRT (Basic concepts only).

20 hours

Module 2: Large sample tests concerning mean, equality of means, proportions, equality of proportions. Smallsample tests based on *t* distribution for mean, equality of means and paired *t* test, one-way ANOVA. (Include real life applications and practical problems):

30 hours**Module 3**: Tests based on chi square distribution – Test for the significance of population variance, goodness of fit and for independence of attributes. Tests based on *F* distribution, Test for correlation coefficients. (Include real life applications and practical problems).

20 hours.

Module 4: Non parametric tests - advantages, disadvantages; Kolmogorov - Smirnov test; one sample and twosample sign tests; Wilcoxon signed rank test; Median test; Mann Whitney test; Kruskal Wallis test and test forrandomness (run test). (Include real life applications and practical problems).

Practicals based on statistical test procedures used in medical/biological/agricultural fields using R software which include the statistical tools ; small and large sample tests (mean, variance, proportions etc.), ANOVA, chi square test of independence of attributes. 20 hours

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

BST5B05: MATHEMATICAL METHODS IN STATISTICS

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20
MarksDuration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Learn the basic concepts of real number system and its properties.
CO 2: Learn the various tests for sequences and series and able to find the limits.
CO 3: Learn to compute the limits of functions.
CO 4: Verify the continuity and differentiability of functions.
CO 5: Learn the concepts in Riemann integration method.

Module 1: Real Number system: Mathematical induction, order properties of real number, Bernoulli, Cauchy, triangle inequality, absolute value, Completeness property-suprema & infima, Archimedean property, Density theorem, nested interval property.

20 hours

Module 2: Sequences and Series: Definition of sequence and subsequence, Limit of a sequence, convergent and divergent sequences, bounded sequences, Monotone sequences, operations on convergent and divergent sequences, Limit superior and limit inferior, convergent and divergent series, series with nonnegative terms, Tests for convergence-Cauchys Root, D Alemberts Ratio Test and Raabe's Test (without proof), alternating series, conditional convergence and absolute convergence, rearrangement of series, test for absolute convergence.

25 hours

Module 3: Functions: Limits, continuity and differentiation: Introduction to limits of functions, limit theorems and problems (without proof). Continuous functions: Definition, Boundedness theorem, Maximum minimum theorem, Location of roots theorem, Intermediate value theorem, uniform continuity, Differentiation, Interior extremum theorem, Rolle's theorem, Mean value theorem, Taylor's theorem.

25 hours

Module 4: Riemann Integration: Definition, Integrability criteria, integrability of continuous and monotone functions, properties of integrals, first and second fundamental theorems on integral calculus.

20 hours

References

1. Malik S.C. and Savitha Arora, Real Analysis, New Age International
2. Robert G Bartle, Real Analysis, Wiley
3. Shanti Narayanan, Elements of Real Analysis
4. Goldberg R.R (2007), Methods of real analysis, Oxford and IBH publishing Company

BST5B06: SAMPLE SURVEYS

Contact Hours per week: 5
Number of credits: 5
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20
MarksDuration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Learn the basic concept of sample survey and its need
CO 2: Equip students with Sampling Techniques used in conducting sample surveys.
CO 3: Compare the efficiency of various estimation strategies resulting from different sampling techniques.

Module 1: Census and Sampling, principal steps in sample survey-probability sampling, judgment sampling, organization and execution of large sample surveys, sampling and non- sampling errors, preparation of questionnaire.sample size determination; prevalence study, cohort study,

20 hours

Module 2: Simple random sampling with and without replacement- methods of collecting simple random samples, unbiased estimate of the population mean and population total-their variances and estimate of these variances-simple random sampling for proportions. 20 hours

Module 3: Stratified random sampling: estimation of population mean and total, proportional and Neymann allocation of sample sizes-cost function-optimum allocation considering cost- comparison with simple randomsampling. Systematic Sampling: Linear and circular systematic sampling, comparison with simple random sampling. 30 hours

Module 4: Cluster sampling: Clusters with equal sizes-estimation of the population mean and total, comparison with simple random sampling, two stage cluster sampling-estimate of variance of population mean.
Practicals based on statistical analysis of data related to medical/biological/agricultural fields using R software which include the statistical tools ; simple random sampling, systematic sampling, stratified sampling, cluster sampling, convenience sampling ,quota sampling and judgment sampling.

20 hours

References

1. Murthy M N, Sampling theory and methods, Statistical Publishing society, Calcutta
2. Daroja Singh and F S Chaudhary, Theory and Analysis of Sample Survey Designs, Wiely EstrnLimitted
3. Cochran W.G, Sampling Techniques, Wiely Estern

BST5B07: LINEAR REGRESSION ANALYSIS

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Acquire the concept of linear regression models.
CO 2: Learn how to interpret the regression coefficients.
CO 3: Acquire the knowledge of the assumptions of linear regression analyses, identify violation of the assumptions and learn possible remedies for the violations.
CO 4: Develop the skill of performing linear regression analyses in practice and checking that assumptions of the model are fulfilled.
CO 5: Learn about logistic regression, identify the situations in which the model can be used.
CO 6: Develop the skill of performing statistical analyses using logistic regression model.

Module 1: Regression and Model building: Scatter diagram, regressor, response, error, uses of regression. Simple linear regression: Simple liner regression model, assumptions, Least square estimation of parameters, Properties of the Least-square estimators and the fitted Regression Model. Estimation of σ^2, Hypothesis testing of slope and intercept. Interval estimation of regression parameters (Slope, intercept and σ^2). Coefficient of determination. Estimation of regression parameters by the method of Maximum likelihood.

25 hours

Module 2: Multiple Linear Regression: Multiple linear regression model, assumptions, least square estimation of parameters, Properties of the Least-square estimators, Hypothesis testing in Multiple linear regression (ANOVA), Test on individual regression coefficients, Interval estimation of coefficients, slope and intercept, co-efficient of determination.

20 hours

Module 3: Model adequacy checking: Residual analysis, Methods of scaling residuals–standardized residuals, studentized residuals, PRESS residuals, R- Student. Residual plots– Normal probability plots, plot of residuals against fitted values, plot of residuals against the regressor, plot of residuals in time sequence. PRESS Statistic, R^2 for prediction based on PRESS.

25 hours

Module 4: Polynomial and logistic regression: Polynomial models in one variable and two variables, Piece wise polynomial fitting (Basic concept only). Logistic regression- model with binary response variable, Applications of logistic regression model, Estimation and Interpretation of the Parameters in logistic regression model.

Practicals based on statistical analysis of data related to medical/biological/agricultural fields applying logistic regression using R software.

20 hours

References

1. D C. Montgomery, E A Peak and G G Vining, Introduction to Linear regression analysis, Wiley 2003.
2. Seber, Linear Regression Analysis, Wiley 1977.
3. D. D Joshi, Linear Estimation and Design of Experiments, Wiley 1987.

4. D N Gujarathi, D C Porter and G Sangeetha, Basic Econometrics, Mc Graw Hill, 20

BST5B08L: STATISTICAL COMPUTING

Contact Hours per week: 5
Number of credits: 5
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 3 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Develop scienfific and experimental skills to the studens.

CO 2: Install and load the packages required for the data analysis.

CO 3: Write R codes for the statistical analysis of data.

An introductory section is included in the course to familiarise the students with the basics of R package.

Introduction to R: R as a calculator, statistical software and a programming language, R preliminaries, getting help, data inputting methods(direct and importing from other spread sheet applications like Excel), data accessing, and indexing, Graphics in R, built in functions, saving, storing and retrieving work. Looping and Decision making – *for* loop, *while* loop, *if* command, *if else* command.

The practical is based on the following modules:

Module 1. Diagrammatic representation of univariate and bivariate data - box plots, stem and leaf diagrams, bar plots, pie diagram, scatter plots.

Module 2. Descriptive statistics - measures of central tendency (mean, median and mode), partition values, measures of dispersion (range, standard deviation, mean deviation and inter quartile range), summaries of a numerical data, skewness and kurtosis, random sampling with and without replacement.

Module 3. Probability Distributions: Random number generation, Binomial, Poisson, Normal.

Module 4. Statistical Inference: One- and two-sample tests, z test, t-test, F-test, chi-square test of independence and goodness of fit, interval estimation for mean, difference of mean and variance, tests for normality (Shapiro-Wilks test, Wilcoxon's test and q-q plot), ANOVA (one- way)

Module 5. Correlation and regression analysis (bivariate and multivariate data), polynomial regression, logistic regression.

Practical is to be done using R package. At least five statistical data oriented/supported problems should be done from each course. Practical record shall be maintained by each student and the same shall be submitted for verification at the time of external examination.

The Board of examiners (BoE) shall decide the pattern of question paper. The duration of the external examination is 3 hours. The external examination at each centre shall be conducted and evaluated on the same day jointly by two examiners – one external and one internal, appointed at the centre of the examination by the college on the recommendation of the Chairman, BoE. The question paper for the external examination at the centre will be set by the external examiner in consultation with the Chairman, BoE and HoD of the centre. The questions are to be evenly distributed over the entire syllabus. Evaluation shall be done by assessing each candidate on the scientific and experimental skills, the efficiency of the algorithm/program implemented, the presentation and interpretation of the results.

References:

1. Michale J. Crawley, THE R BOOK, John Wiley & Sons, England (2009)
2. Sudha G. Purohit et.al., Statistics Using R, Narosa Publishing House, , India(2008)
3. John Verzani, simple R-Using R for Introductory Statistics, (http:// www.math.csi.cuny.edu/Statistics/R/SimpleR/Simple.)
4. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R , Notes on R: A Programming Environment for Data Analysis and Graphics, Version 2.15.2 (2012-10-26) (http://www.r-project.org)

BST6B09: TIME SERIES AND INDEX NUMBERS

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Explain the components of a time series.
CO 2: Describe the methods of measuring trend and seasonal variations.
CO 3: Know about different types of index numbers .
CO 4: Compute Cost of Living index number and use it in calculation of purchasing power of money and deflation of income.
CO 5: Describe lognormal distribution and Pareto distribution for modelling income.
CO 6: Apply Lorenz curve and Gini's coefficient for measuring income inequality.
CO 7: Explain issues in measurement of attitudes and different scales of measurement.
CO 8: Select appropriate scale for attitude measurement.

Module 1: Time series analysis: Introduction, Components of time series, Mathematical models for time series- additive, multiplicative and mixture models, Uses of time series, Measurement of trend, Growth curves (Concepts only), Measurement of seasonal fluctuations- Simple averages, Ratio to trend, Ratio to moving average and Link relative methods, De-seasonalisation of data.
Practicals based on statistical analysis of data related to medical/biological/agricultural fields applying time series analysis using R software .

25 hours

Module 2: Analysis of Income and allied distributions-Pareto distribution, graphical test, fitting of Pareto's law, illustrations, lognormal distribution and properties, Lorenz curve, Gini's coefficient .

20 hours

Module 3: Index numbers: Meaning and definition-uses and types-problems in the construction of index numbers-simple aggregate and weighted aggregate index numbers. Test for consistency of index numbers-factor reversal, time reversal and unit test, Chain base index numbers-Base shifting-splicing and deflating of index numbers. Consumer price index numbers-family budget enquiry-limitations of index numbers.

30 hours

Module 4: Attitude Measurements and Scales: issues in attitude measurements, scaling of attitudes, Guttman scale, Semantic differential scale, Likert scale; selection of appropriate scale, limitations of scales.

15 hours

References

1. SC Gupta and V K Kapoor, Fundamentals of applied statistics, Sulthan chand and sons
2. Goon A M, Gupta M K and Das Gupta, Fundamentals of Statistics Vol II, The World press, Calcutta
3. Box G E P and Jenkins G M, Time series analysis, Holden Day
4. Meister David, Behavioral Analysis and Measurement methods, John Wiley New York
5. Luck et al. Marketing Research, Prentice Hall of India, New Delhi

BST6B10. DESIGN OF EXPERIMENTS

Contact Hours per week: 5
Number of credits: 5
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Learn the concept of linear model, estimability and its associated properties.
CO 2: Know the statistical tool ANOVA to analyze one way and two way classified data.
CO 3: Learn the basic principles in designing experiments and discuss various designs of experiments.
CO 4: Learn the basic concepts of factorial experiments and balanced incomplete block designs.
CO 5: Know the application of various designs of experiments and its analysis in different fields such as agriculture, biological sciences and industry.

Module 1: Linear estimation, estimability of parametric functions and BLUE Gauss- Markov theorem-Linear Hypothesis.

15 hours

Module 2: Analysis of variance, one way and two way classification (with single observation per cell), Post Hoc Tests - Least Significant Difference (LSD) test, Duncan's multiple range test. Analysis of covariance with a single observation per cell (Concept and model only).

15 hours

Module 3: Principles of design-randomization-replication-local control, completely randomized design; Randomized block design; Latin square design. Missing plot technique; comparison of efficiency; Greco-Latin square design (Concept only).

35 hours

Module 4: Basic concepts of factorial experiments, 2^2 and 2^3 factorial experiments, Basic concepts of Incomplete block design, Balanced incomplete block design and Partially Balanced incomplete block design (Concept only) .
Practicals based on statistical analysis of data related to medical/biological/agricultural fields using R software which include the statistical tools ; completely randomized design, randomized block design, latin square design, factorial experiments.

25 hours

References

1. S.C. Gupta and V K Kapoor, Fundamentals of applied Statistics, Sulthan Chand and Sons
2. M N Das and N Giri, Design of Experiments, New Age international,
4. D.D Joshy, linear Estimation and Design of Experiments, Wiley Eastern
5. Montgomery, D C, Design and Analysis of Experiments, John Wiley

BST6B11: POPULATION STUDIES, ACTUARIAL SCIENCE AND VITAL STATISTICS

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Impart basic concepts in population studies, actuarial science and vital statistics.
CO 2: Learn about the life tables and its characteristics.
CO3: Prepare students to take up a career in Actuarial Practice.

Module 1: Sources of vital statistics in India-functions of vital statistics, Rates and ratios-mortality rates-crude, age specific and standard death rates-fertility and reproduction rates- crude birth rates-general and specific fertility rates-gross and net reproduction rates.
Practicals based on statistical analysis of data related to medical/biological fields using R software which include the statistical tools ; birth rate, death rate, fertility rate,

30 hours

Module 2: Life Tables-complete life tables and its characteristics-Abridged life tables and its characteristics, principle methods of construction of abridged life tables-Reed Merrel's method

30 hours

Module 3: Actuarial Science: What is an Actuarial Science? Insurance companies as Business organizations, Concept of Risk, Speculative and pure risk, Characteristics of insurable risks, how does the Insurance business operates? Role of Statistics in Insurance, History of Insurance business in India.

10 Hours

Module 4: Fundamentals of Insurance: Insurance, Features of a contract, Principles of insurance, Peril, Hazard, Types of Hazard, Costs and benefits of insurance to Society, Insurance Business classification- Life (Whole life, term assurance, endowment, money back, ULIP) and non-life (Fire, Marine, Miscellaneous), Difference between life and non-life insurance.

20 Hours

References

1. Shailaja R Deshmukh (2009), Actuarial Statistics: An introduction using R, Universities Press.
2. S.C. Gupta and V K Kapoor, Fundamentals of applied Statistics, Sulthan Chand andSons
3. Benjamin B, Health and Vital Statistics, Allen and Unwin
4. Mark S Dorfman, Introduction to Risk Management and Insurance, PrenticeHall
5. C.D.Daykin, T. Pentikainen et al, Practical Risk Theory of Acturies, Chapman andHill

BST6B12: OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL

Contact Hours per week: 5
Number of credits: 4
Number of Contact Hours: 90
Course Evaluation: External 80 Marks+ Internal 20 Marks
Duration of Exam: 2.5 Hours

***Course Outcomes**: After successful completion of the course, students will be able to:*

CO 1: Demonstrate the various types of optimization techniques.
CO 2: Determine optimum solution of LPP by graphical and simplex method.
CO 3: Compute initial basic feasible solution of transportation problem by different methods.
CO 4: Solve assignment problem.
CO 5: Identify different causes of variations in quality control.
CO 6: Construct control charts for mean, range, standard deviation, proportion.
CO 7: Discuss principles of acceptance sampling.
CO 8: Explain the concept of AQL, LTPD, AOQL, ASN etc.

Module 1: Linear programming: Mathematical formulation of LPP, Solution of LPP-Graphical method, Simplex method, Big M method, Two Phase method, duality in linear programming(concepts and problems). 20 hours

Module 2: Transportation problems – Finding initial basic feasible solution, test for optimality, degeneracy in transportation problem, transportation algorithm (MODI method), Assignment problem, Hungarian algorithm of solution. 20 hours

Module 3: General theory of control charts, causes of variations in quality, control limits, control charts for variables: X bar chart, R Chart and sigma chart, Revised control charts, criteria for detecting lack of control in X bar and R chart, control charts for attributes, np chart, p chart, c chart, applications and advantages.
Practicals based on statistical analysis of data related to medical/biological/agricultural fields using R software which include the statistical tools; mean chart, range chart, c chart, p chart in statistical quality control

25 hours

Module 4: Principles of acceptance sampling- AQL, LTPD, Process average fraction defective, consumer's risk and producer's risk, Rectifying inspection plan, AOQ and AOQL, OC curve, Average Sample Number (ASN) and Average Amount Of Total Inspection (ATI), single and double sampling plans, their ATI, ASN and OC functions.

25 hours

References

1. Kanti swarup, Gupta and Manmohan, Operations Research, Sulthan Chand and sons
2. Hardley G, Linear programming, Addison-Wesley
3. Taha, Operations Research, Macmillan,
4. V.K.Kapoor, Operations Research, Sultan Chand and Sons
5. S.C.Gupta and V.K.Kapoor Fundamentals of Applied Statistics, Sultan Chand and Sons

BST6B13P: PROJECT WORK

Contact Hours per week: *4 (V semester-2 and VI semester-2)*
Number of credits: *2*
Number of Contact Hours: *72*
Course Evaluation: *External 80 Marks+ Internal 20 Marks*

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Enhance their Research attitude.
CO 2: Apply the theory of research in real life situations.
CO 3: E xposure to study the working atmosphere of an enterprise and undertake research on any socially relevant area based on their various courses.

The following guidelines may be followed for project work.

1. The project is offered in the fifth and sixth semester of the degree course and the duration of the project may spread over the complete year.
2. A project may be undertaken by a group of students, the maximum number in a group shall not exceed 5. However the project report shall be submitted by each student.
3. There shall be a teacher from the department to supervise the project and the synopsis of the project should be approved by that teacher. The head of the department shall arrange teachers for supervision of the project work.
4. As far as possible, topics for the project may be selected from the applied branches of statistics, so that there is enough scope for applying and demonstrating statistical skills learnt in the degree course.
5. Field/Industrial/Organization visit is mandatory for the data collection.

ELECTIVE COURSES

1. BST6E01: PROBABILITY MODELS AND RISK THEORY

Contact Hours per week: 3
Number of credits: 2
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: After successful completion of the course, students will be able to:

CO 1: Learn the different types of risk models.
CO 2: Apply the risk theory in insurance.

Module 1: Individual risk model for a short time: Model for individual claim random variables-sums of independent random variables-Approximation for the distribution of sum-Application to insurance.
10 hours

Module 2: Collective risk models for a single period: The distribution of aggregate claims-selection of basic distributions-properties of compound Poisson distribution-approximation to the distributions of aggregate claims. 15 hours

Module 3: Collective risk models over an extended period: Claims process-The adjustment coefficients-Discrete time model-the first surplus below the initial level-The maximal aggregate loss. 15 hours

Module 4: Application of risk theory: Claim amount distributions approximating the individual model-stop-loss re-insurance-the effect of reinsurance on the probability of ruin. 14 hours

References

1. Institute of Actuaries, Act Ed. Study Materials
2. McCutcheon, JJ, Scott William (1986): An introduction to Mathematics of Finance
3. Butcher M V, Nesbit, Cecil (1971) Mathematics of Compound Interest, Ulrich's book
4. Neil, Alistair, Heinemann (1977) Life contingencies
5. Bowers, Newton Let et al (1997) Actuarial mathematics, society of Actuaries, 2nd

2. BST6E02: STOCHASTIC PROCESSES

Contact Hours per week: 3
Number of credits: 2
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Learn modeling of uncertainty through random variables.

CO 2: Acquire the concept of stochastic processes and their properties.

Module 1: Conditional Probability, compound probability, Baye's theorem. Probability generating functions. 6 hours

Module 2: Definition of stochastic process, Four classifications of Stochastic Processes, Markov Property, Markov process, Markov Chain, Graphical representations. Initial distributions (problems), Transition probabilities, Chapmann and Kolmogrov equations, Transition probability matrices (examples and computation). Higher order transition probabilities (P^n). 30 hours

Module 3: Accessibility and communication of states. First passage probabilities, classification of states (recurrent, transient), mean recurrence. Periodicity, Ergodic theorem (Statement only), irreducible, class property. Stationary distribution. Limiting distribution (Definition and problems only).

18 hours

References

1. Medhi, J(1996). Stochastic Processes, Wiley Eastern Limited.
2. Karlin, S and Taylor, H.M.(1978). An Introduction to Stochastic Modeling (3^{rd} edition), Academic Press
3. Karlin, S and Taylor, H.M.(1978). A first course in Stochastic Processes. Academic Press, New York.
4. Ross, S.M.(1983). Stochastic Processes, John Wiley and Sons.

3. BST6E03: RELIABILITY THEORY

Contact Hours per week: 3
Number of credits: 2
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Describe the structural properties of coherent systems.

CO 2: Determine the reliability of a system.

CO 3: Discuss the different parametric distributions in reliability

Module 1: Structural properties of coherent Systems: System of components series and parallel structure with example-dual structure function-coherent structure-preservation of coherent system in terms of paths and cuts representation of bridge structure-times to failure-relative importance of components-modules of coherent systems. 20 hours

Module 2: Reliability of Coherent systems: Reliability of a system of independent components-some basic properties of system reliability-computing exact system reliability-inclusion exclusion method-reliability importance of components. 20 hours

Module 3: Parametric distributions in reliability: A notion of ageing (IFR and DFR only) with examples-exponential distribution-Poisson distribution. 14 hours

References

1. R E Barlow and F Proschan (1975) Statistical Theory of Reliability and life testing, Holt Rinhert, Winston
2. N Ravi Chandran, Reliability Theory, Wiley Eastern

OPEN COURSES

1. BST5D 01: ECONOMIC STATISTICS

Contact Hours per week: 3
Number of credits: 3
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Explain the components of a time series.
CO 2: Describe the methods of measuring trend and seasonal variations.
CO 3: Know about different types of index numbers .
CO 4: Learn the tests for consistency of index numbers.

Module 1: Time series analysis: Economic time series, different components, illustrations, additive and multiplicative models, determination of trends, growth curves, analysis of seasonal fluctuations, construction of seasonal indices.

24 hours

Module 2: Index numbers: Meaning and definition-uses and types-problems in the construction of index numbers-simple aggregate and weighted aggregate index numbers. Test for consistency of index numbers-factor reversal , time reversal and unit test, Chain base index numbers-Base shifting-splicing and deflating of index numbers. Consumer price index numbers-family budget enquiry-limitations of index numbers.

30 hours

References

1. S C Gupta and V K Kapoor, Fundamentals of Applied Statistics, Sulthan Chands andsons
2. Goon A M, Gupta M K and Das Gupta, Fundamentals of Statistics Vol II, The World Press, Calcutta.

2. BST5D 02: QUALITY CONTROL

Contact Hours per week:3
Number of credits: 3
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Identify the basics of quality control.

CO 2: Construct the control charts

CO 2: Describe quality assessment techniques.

Module 1: General theory of control charts, causes of variations in quality, control limits, sub-grouping, summary of out-of-control criteria, charts of attributes, np chart, p chart, c chart, Charts of variables: X bar chart, R Chart and sigma chart, Revised control charts, applications and advantages. 30 hours

Module 2: Principles of acceptance sampling-problems of lot acceptance, stipulation of good and bad lots-producer' and consumer' risk, simple and double sampling plans, their OC functions, concepts of AQL, LTPD,AOQL, Average amount of inspection and ASN function. 24 hours

References

1. Grant E L, Statistical quality control, McGraw Hill
2. Duncan A J, Quality Control and Industrial Statistics, Taraporewala andsons
3. Montegomery D C, Introduction to Statistical Quality Control, John Wiley and son

3. BST5D 03: BASIC STATISTICS

Contact Hours per week: 3
Number of credits: 3
Number of Contact Hours: 54
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Explain the sampling techniques used in conducting sample surveys.
CO 2: Compare various measures of central tendencies and dispersion. .
CO 3: Know the basic concepts of probability theory.
CO 4: Solve problems in probability theory.
CO 5: Distinguish between Univariate and bivariate data.
CO 6: Compute correlation coefficient.

Module 1: Elements of Sample Survey: Census and Sampling, advantages, principal step in sample survey-sampling and non-sampling errors. Probability sampling, judgment sampling and simple random sampling. 10 hours

Module 2: Measures of Central tendency: Mean, median and mode and their empirical relationships ; Measures of Dispersion: absolute and relative measures, standard deviation and coefficient of variation. 12 hours

Module 3: Fundamental characteristics of bivariate data: univariate and bivariate data, scatter diagram, Pearson's correlation coefficient, limit of correlation coefficient. Curve fitting, principle of least squares, fitting of straight line. 15 hours

Module 4: Basic probability: Random experiment, sample space, event, algebra of events, Statistical regularity, frequency definition, classical definition and axiomatic definition of probability-addition theorem, conditional probability, multiplication theorem and independence of events (limited to three events). 17 hours

References

1. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
2. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
3. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
4. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, New Delhi

STATISTICS: MODEL QUESTION PAPERS OF CORE COURSES

BST1B01: OFFICIAL STATISTICS AND PROBABILITY

Time: 2½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks

1. Write any two main features of Indian Statistical System.
2. Write about the publications of CSO.
3. Distinguish between inclusive and exclusive classes.
4. What are ogives? How will you construct it?
5. Define Primary data and Secondary data.
6. Obtain the median for the following frequency distribution

X	1	2	3	4	5	6
Frequency	8	10	11	16	20	25

7. Establish the relationship between AM, GM and HM.
8. The mean, median and standard deviation of a moderately asymmetrical distribution are 25, 23 and 4.5 respectively. Calculate Pearson's coefficient of skewness.
9. Define Coefficient of variation.
10. What is a scatter diagram?
11. Write down the normal equation for fitting an exponential curve $y = ab^x$
12. Why are there two regression lines?
13. Define random experiment. Write an example.
14. Define conditional probability.
15. State the axiomatic definition of probability. Maximum Marks =25

PART B

Each question carries 5 marks

16. Write a note on statistical system in states.
17. Explain diagrammatic representation of data in common use.
18. Calculate CV of the following two series and show which series is more consistent?

Weight	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Class A	1	2	9	8	5	4	1
Class B	3	3	7	10	5	3	1

19. Explain skewness and kurtosis.
20. Fit a parabola to the following data.

x	1	2	3	4	5	6	7	8	9	10
y	2	6	7	8	10	11	11	10	9	9

21. Given two regression lines 4y=9x+15 and 6y=25x-7. Identify the regression lines and obtain coefficient of correlation between x and y.

22. State and prove Baye's theorem.

23. A problem in Statistics is given to 3 students A,B and C whose chances of solving it are ½, ¾ and ¼ respectively. What is the probability that the problem will be solved?

Maximum marks= 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. Draw less than ogive and more than ogive and obtain median

Class	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Freq	12	16	24	30	22	14	8

25. Find the mean,median,mode, GM , HM. and QD for the following data

Class	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Freq	5	12	18	24	17	15	9

26. Compute Spearman's rank correlation coefficient for the data.

x	50	60	50	60	80	50	80	40	70
y	30	60	40	50	60	30	70	50	60

27. An insurance company insured 3000 scooter drivers, 2000 car drivers and 5000 truck drivers. The probabilities of accident by the drivers of these types of vehicles are 0.04,0.02,0.03 respectively. One of the insured people meet an accident. What is the probability that he is a truck driver?

BST2B02: BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS

Time: 2½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks

1. Distinguish between discrete and continuous random variables.
2. Define distribution function. Write any two properties of distribution function
3. Let f(x) = 2x+3, 0 <x < 1; 0 otherwise. Verify whether f(x) is a probability density function or not.
4. Show that V(aX + b) =a^2V(X).
5. Let X1 and X2 be two independent random variables. Prove that M X1+X2(t) = MX1(t) MX2(t).
6. For a discrete bivariate random variable (X, Y), prove that E{E(X|Y)} =E(X)
7. If X and Y are two independent random variables then show that Cov(X, Y) =0.
8. Define Binomial random variable.
9. Derive the mean of a Poisson random variable.
10. Derive the m.g.f of Uniform distribution on (0,1).
11. If X is a random variable with a continuous distribution function F. Then show that F ~ Uniform[0,1]
12. Write the relationship between normal and log normal distributions.
13. Derive the moment generating function of Gamma distribution.
14. State Lindberg-Levy central limit theorem.
15. Define convergence in probability.

Maximum Mark = 25

PART B

Each question carries 5 marks

16. Let f(x) = 1, 0<x<1; 0 otherwise. Find the distribution of Y= -2logX.
17. For a discrete r.v. X with probability distribution.

x	-2	-1	0	1	2
P(X=x)	0.1	0.2	0.3	k	0.2

find the value of (i) k (ii) p(-1 $\leq X \leq$ 1)

18. A random variable X has the density function f(x) = 1/2√x; 0 < x < 1 Obtain the m.g.f. of X and hence find its mean and variance.
19. The joint pdf of a bivariate random variable ifs f(x y) = 2; 0 < x < 1; 0 < y < x. Check for independence of X and Y.
20. Show that V(X) = E[V(X|Y)] +V[E(X|Y)]
21. Let X and Y are two independent and identically distributed geometric random variables. Then show that the conditional distribution of X|X+Y = n is uniform.
22. Establish the memory less property of geometric distribution.
23. Let X is a normal variate with mean 42 and standard deviation 4. Find the probability that a value taken by X is (i) less than 50, (ii) greater than 50, (iii) greater than 40, (iv) in between 40 and 50.

Maximum Mark =35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. If (X, Y) is a bivariate discrete random variable with joint probability mass function

X / Y	1	2	3
1	$\frac{2}{21}$	$\frac{3}{21}$	$\frac{4}{21}$
2	$\frac{3}{21}$	$\frac{4}{21}$	$\frac{5}{21}$

(i) Find the marginal distributions of X and Y (ii) Compute P(X|Y=1) and(ii) Compute P(Y|X=2)

25. If X and Y are two r.v.s having the joint pdf $f(x\ y) = 2 - x - y\ ;\ 0 < x, y < 1$. Find ρxy.
26. Show that Poisson distribution is a limiting case of Binomial distribution under certain conditions.
27. State and establish Bernoulli's law of large numbers.

(**2 × 10 = 20**)

BST3B03: STATISTICAL ESTIMATION

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Define parameter and statistic.
2. Explain estimator and estimate.
3. Define sampling distribution.
4. State the additive property of Chi square distribution.
5. What are the properties of F distribution?
6. Define student's t statistic.
7. Define consistent estimator. Given an example.
8. Establish the relationship between t and F distributions.
9. State the regularity condition of Cramer-Rao inequality.
10. State Neyman –Pearson Factorization theorem.
11. Define unbiasedness and efficiency of an estimator.
12. What is the significance of Bayesian estimation method?
13. Explain interval estimation.
14. Define confidence interval and confidence coefficient.
15. Write the confidence for the mean of normal distribution when population standard deviation is unknown.

Maximum Mark = 25

PART B

Each question carries 5 marks

16. Derive the sampling distribution of mean of samples from a normal population.
17. Explain the method of moments.
18. If two independent random samples of sizes 15 and 20 are taken from $N(2, 4^2)$. Whatis the probability of $(S_1^{\,2}/ S_2^{\,2}) < 2$.
19. Derive the moment generating function of X^2 distribution
20. Prove that in a Normal distribution sample mean is a consistent estimator of population mean.
21. If F→F (n1, n2) then find the distribution of 1/F.
22. Find the maximum likelihood estimator of λ for the Poisson distribution.
23. Derive the confidence interval for population mean

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. Define standard normal distribution. In normal distribution, 31% of the items are under 45 and 8% are over 64. Find the mean and variance of the distribution.

25. X is a normal variate with mean 42 and standard deviation 4. Find the probability that a value taken by X is (i) less than 50, (ii) greater than 50, (iii) greater than 40, (iv) in between 40 and 50 and (v) equal to 45.

26. Derive Student's t distribution and state some important of its applications.

27. Find the MLE for random sampling from a normal population N(μ, σ^2) for (i) population mean μ when the population variance $\sigma^2$is known (ii) population variance σ^2 when the population mean μ is known(iii) population mean μ and population variance σ^2 when both unknown.

(2 × 10 = 20)

BST4B04- TESTING OF HYPOTHESIS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Define simple and composite hypotheses.
2. Distinguish between Type I error and Type II error.
3. Discuss sequential sampling.
4. What is the significance of SPRT?
5. Distinguish between small sample tests and large sample tests.
6. Write the critical regions of large sample test.
7. Compare parametric and non-parametric tests
8. Write a suitable situation where ANOVA test is applicable.
9. List the assumptions of one sample t test.
10. When do you use Yate's correction?
11. Identify a suitable test and its test statistic for testing the significance of a correlation coefficient.
12. What is meant by goodness of fit?
13. Explain short note on Median Test
14. Write t h e test statistic of Wilcoxon-signed rank and identify its asymptotic distribution.
15. Briefly discuss run test.

Maximum Mark = 25

PART B

Each question carries 5 marks

16. The continuous random variable X has the frequency function

$$f(x) = \lambda e^{-x}, \text{ x}\geq 0, 0 \text{ otherwise}$$

It is desired to test the hypothesis $H_0 : \theta=2$ *against* $H_1 : \theta=1$ using a single observation X. X ≥ 1 is used as the critical region. Evaluate P(Type I error) and P(Type II error).

17. Explain pared t test. Give a practical situation where this test is suitable.
18. A sample of 25 boys who passed SSLC examination are found to have mean marks 50 with standard deviation 5 for English. The mean marks of 18 girls are found to be 48 with standard deviation 4 for the same subject. Does this indicate any significance difference between the marks of boys and girls assuming the population standard deviation are equal?
19. In a sample of 600 men from a certain city 400 are fund to be smokers In 900 from another city 450 are smokers Do the data indicate that the cities are significantly different as far as smoking habits of people are concerned.
20. Tests were carried out to assess the strength of single fiber yarn spun on two different machines A and B and the results are given below:

Machine A	4	4.4	3.9	3	4.2	4.4	5
Machine B	5.3	4.3	4.1	4.4	5.3	4.2	3.8

Assuming the samples have been taken from normal population, test the hypothesis that variability is same for both the machines.

21. Explain Chi square test for independence of attributes.
22. A sample of 10 men was used in a study to test the effects of a relaxant on the time required to fall asleep for male adults. Data for 10 subjects showing the number of minutes required to fall asleep with and without the relaxant follow. Use a 0.05 level of significance to determine whether the relaxant reduces the time required to fall asleep. Perform sign test and draw your conclusion.

Subject	1	2	3	4	5	6	7	8	9	10
Without Relaxant	23	25	27	13	15	16	25	27	38	21
With Relaxant	21	24	23	12	9	14	28	29	18	11

23. Explain Kolmogorov-Smirnov test. Suggest a situation where this test is useful.

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. State Neyman Pearson Lemma. Use the lemma to obtain the best critical region for testing $H_0 : \mu=\mu_0$ against $H_1 : \mu=\mu_1$, in the case of a normal population with mean μ and variance σ^2 . Find the power of the test.

25. List basic assumptions of ANOVA and explain the procedure or performing an ANOVA test.
26. Fit a binomial distribution for the following data and test the goodness of fit.

X	0	1	2	3	4
frequency	8	32	34	24	5

27. Explain (i) Wilcoxon signed rank test and (ii) Mann Whitney test

$2 \times 10 = 20$

BST5B05-MATHEMATICAL METHODS IN STATISTICS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Write any two properties of real numbers?
2. Show that every convergent sequence is bounded
3. Find the region of x in $| \quad + 1| < 1.$
4. State Taylor's theorem.
5. What is nested intervals?
6. Compute $\lim_{n \to \infty} (n!)^{1/n}$.
7. Why the set of rational numbers is not order-complete?
8. Write triangle inequality for two variables.
9. Identify the sixth term in the sequence {7, 26, 63, 124, 215, ….}.
10. Find —
11. Discuss the relationship between continuity and differentiability of a function.
12. State a sufficient condition for uniform continuity.
13. Define Riemann integral.
14. Write the necessary and sufficient condition for a bounded function *f* is to be integrable.
15. Prove or disprove $\int^b f(x)dx = - \int^a f(x)dx$

Maximum Mark = 25

PART B

Each question carries 5 marks

16. If {xn} and {yn} are two sequences of real numbers converging to real numbers x and y respectively. Show that {xn yn} converges to xy.
17. State and Prove Archmedian Property of Real numbers
18. Show every bounded sequence of real numbers has a convergent subsequence.
19. Show that every monotone sequence of bounded real numbers is convergent
20. State and prove mean value theorem
21. Establish Rolle's Theorem.
22. Prove that a bounded and continuous function f(.) over a closed interval (finite) is a sufficient condition for integrability.
23. If Q is a refinement of P, show that L(P,f)$\leq$ U(Q,f).

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. /State and prove Cauchy convergence criteria
25. State and prove principle of Mathematical induction
26. State and prove intermediate value theorem.
27. If f and g are integrable then check whether the following are integrable or not:

a) $|f|$ b) f^2 c) $f.g$ 2 x 10 =20

BST5B06: SAMPLE SURVEYS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Distinguish between census and sampling.
2. What is meant by judgement sampling?
3. Define secondary data. State its major sources.
4. Compare sampling and non-sampling errors.
5. Write any four properties of a good questionnaire.
6. Discuss simple random sampling.
7. Compute the total number of samples of size n = 2 from a population of N = 6.
8. Write the unbiased estimate of population total and its variance.
9. Write Bowley's formula for proportional allocation.
10. In a systematic sampling N =40 and n = 4, find the value of k.
11. If ρ is the intraclass correlation coefficient between the units of the same systematic sample, then when do you say that systematic sampling would be more efficient as compared with srswor?
12. Briefly explain cluster sampling.
13. Write a situation where two stage sampling is applicable.
14. Distinguish between a stratum and a cluster.
15. Discuss Neyman allocation of sample sizes.

Maximum Mark = 25

PART B

Each question carries 5 marks

16. What are the advantages of sampling over census?
17. Explain the probability sampling and non-probability sampling with the help of examples.
18. Explain the concept of stratified sampling.
19. Obtain an unbiased estimate of population mean in simple random sampling with replacement. Find the variance of the estimate.
20. Show that sample proportion, p is an unbiased estimate of population proportion, P. Also obtain the confidence interval for the population proportion
21. Show that sample mean is an unbiased estimate of population mean in stratified random sampling. Also find its variance.
22. What you mean by precision of an estimate? Show that mean of a systematic sample is more precise than mean of simple random sample.
23. Obtain an unbiased estimator of population mean in cluster sampling. Also find its variance.

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. Explain in detail the principal steps in a sample survey.

25. Show that $va\text{-}y' \quad / = \frac{N-1}{} (1 + (n-1))S^2$ where ρ is the interclass correlation between the units of the same systematic sample.

26. If the population consists of a linear trend, then prove that

$var\ (y'_{st}) \leq var\text{-}y'_{sys} / \leq y'_{ran}$.

27. Compare the efficiencies of the Neyman and proportional allocations with that of an unstratified random sample of the same size.

$2 \times 10 = 20$

BST5B07- LINEAR REGRESSION ANALYSIS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Describe scatter diagram.
2. Write the confidence interval for the slope and intercept in simple linear regression model.
3. List some of the uses of regression.
4. Show that the least square estimate of multiple linear regression coefficient is unbiased.
5. Write the hypotheses and test statistic for testing the significance of slope coefficient in simple linear regression model.
6. Show that the residual mean square is an unbiased estimate of population variance of random error component in linear regression model.
7. Write the properties of least square estimates of simple linear regression coefficients.
8. What is the importance of ANOVA in multiple linear regression?
9. Define hat matrix.
10. Distinguish between R^2 and adjusted R^2.
11. What is the significance of coefficient of determination?
12. Write a situation where logistic regression is applicable.
13. List the assumptions of logistic regression.
14. Define Splines.
15. Define logit function.

Maximum Mark = 25

PART B

Each question carries 5 marks

16. Derive the variance of regression coefficients in simple linear regression
17. Estimate the variance of the response variable.
18. From a study conducted by the Department of transportation on driving speed and mileage for midsize automobiles, following results are obtained:

Driving speed (x)	30	50	40	55	30	25	60	25
Mileage (y)	28	25	25	23	30	32	21	35

Fit a linear regression model for the mileage and interpret the result.

19. Consider the simple linear regression model $= {}_0 + {}_1 + c$ with $(\in) = 0, var(\in) = \sigma^2$, $\in$ uncorrelated.
    (a) Show that cov $(\hat{\beta}_{0,}\hat{\beta}_1) = \frac{-\bar{x}\sigma^2}{}$
    (b) Show that cov $(\bar{y}\hat{\beta}_1) = 0$
20. Describe multiple linear regression model.
21. Discuss the properties of least square estimators in multiple linear regression.
22. Explain polynomial regression models and list some of its applied areas.
23. Explain the logistic regression model with a Binary response variable.

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. Derive the least square estimates of simple linear regression coefficients and show that they are unbiased.

25. Explain the role of residual in model adequacy checking.

26. Explain test for significance of regression coefficients in multiple linear regression

27. Describe the estimation of regression coefficients in logistic regression model.

$2 \times 10 = 20$

BST6B09: TIME SERIES AND INDEX NUMBERS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A
Each question carries 2 marks.

1. Give example for seasonal and cyclic variations in time series.
2. Define Time series
3. What is meant by de-seasonalisation of data?
4. Write the steps for calculating the seasonal index using the method of simple averages.
5. Define moving averages.
6. What is family budget method?
7. Write the importance of lognormal distribution in income analysis.
8. Briefly describe the fitting of Pareto's law.
9. Describe additive models in time series.
10. What is Gini's coefficient?
11. Define index numbers.
12. Mention any three uses of index numbers.
13. Write Marshal-Edgeworth index number and Drobish and Bowley's index number.
14. What are the scales of measurements?
15. Define Guttman scale.

Maximum mark=25

PART B
Each question carries 5 marks

16. How trend is measured using Moving Averages.
17. Explain periodic variations in Time series with suitable examples
18. Describe the Link Relative Method of measuring seasonal variation.
19. Explain Lorentz curve
20. Give major limitations of index numbers
21. Construct the cost of living index number for the following data

Item	Price (in Rs)		Weight
	2001	2005	
A	50	75	10%
B	60	75	25%
C	200	240	20%
D	80	100	40%
E	160	200	5%

22. Briefly explain Link relative methods also explain its merits and demerits.
23. How is a Likert scale measured? Is a Likert scale quantitative or qualitative?

Maximum mark=35

PART C
Each question carries 10 marks (Answer any **TWO** Questions)

24. What are the components of time series explain with example
25. Describe Pareto's law of distribution of income. Give a few situations where Pareto's law holds good.

26. Below are given the production (in thousands of tonnes) of a fertilizer factory.

Year	1995	1997	1998	1999	2000	2001	2004
Production (000's of tonnes)	77	88	94	85	91	98	90

Fit a straight line trend and and tabulate the trend values.

27. What is attitude scale? Explain the advantages and limitations of scales in attitude measurements?

(2 × 10 = 20Marks)

BST6B10: DESIGN OF EXPERIMENTS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A
Each question carries 2 marks.

1. Explain Gauss Markov set up of linear model.
2. Define estimable parametric function.
3. What is meant by best linear unbiased estimator?
4. Discuss the concept of ANCOVA.
5. In a LSD with 4 treatments and error sum of squares is 16, find the Mean error sum of squares.
6. Write any situation where Graeco-Latin square design is suitable.
7. Distinguish between CRD and RBD.
8. Define treatment.
9. How to compare various designs of experiments?
10. In a 2^2 factorial design two factors A and B are given each at two levels, Write down the main effects and interaction effects of A and B.
11. Distinguish between 2^2 and 2^3 factorial designs.
12. Define incidence matrix
13. Discuss orthogonal design.
14. Describe BIBD.
15. What is the significance of PBIBD?

Maximum Mark = 25

PART B
Each question carries 5 marks

16. Consider three independent random variables y_1 , y_2 and y_3 having common variance σ^2 and $E(Y_1)=\theta_1-\theta_2$, $E(Y_2)=\theta_1+\theta_2$, $E(Y_3)=2\theta_1-\theta_2$. Show that $3\theta_1-2\theta_2$ is an estimable parametric function.
17. Find the least square estimate of the parameter vector θ in Gauss - Markov model and also find an unbiased estimator of σ^2.
18. What is meant by analysis of variance of experimental data? What are the assumptions used in it?
19. Give the analysis for completely randomized design
20. Derive the expression for estimating one missing observation in RBD
21. Explain the efficiency of LSD compared to RBD
22. How can estimate the effects and calculate the sum of squares in factorial experiment?
23. Explain Duncan's multiple range test

Maximum Mark = 35

PART C
Each question carries 10 marks (Answer any **TWO** Questions)

24. State and prove Gauss-Markov theorem.
25. What is meant by missing plot technique and what are procedures used to obtain the missing observation. Write the expression for estimating two missing values in LSD and explain the ANOVA table in this case.
26. Explain the principles of design of experiments.
27. Define the main effects and interaction effects in a 2^3 factorial experiment. Also give its ANOVAtable.

$2 \times 10 = 20$

BST6B11: POPULATION STUDIES, ACTUARIAL SCIENCE AND VITAL STATISTICS

Time: 2 ½ Hours **Max.: 80 Marks**

PART A
Each question carries 2 marks.

1. Define vital statistics. Give examples.
2. What is Crude birth rate?
3. Write the relation between N. R. R. And G. R. R.
4. Define mortality rate.
5. Write merits and demerits of general fertility rate.
6. Write any two characteristics of complete life tables.
7. What do you understand by an abridged life table?
8. What are the various uses of vital statistics?
9. What is expectation of life? Distinguish between 'curate expectation' and „complete expectation' of life.
10. Discuss the costs and benefits of insurance to society.
11. Explain different kinds of policies.
12. Explain life insurance and fire insurance.
13. Define peril and hazard.
14. What is proximate cause in insurance?
15. List different branches of insurance.

Maximum Mark =25

PART B
Each question carries 5 marks

16. Explain different methods of obtaining vital statistics.
17. Explain direct method of standardisation.
18. What are the assumptions in a life table?
19. State the merits and demerits of Crude Birth Rate.
20. Differentiate between Life insurance and General insurance.
21. Describe reinsurance and double insurance. Also explain the difference between them.
22. Explain the principles of insurance.
23. Discuss the costs and benefits of insurance to society.

Maximum Mark =35

PART C
Each question carries 10 marks (Answer any **TWO** Questions)

24. Determine the standardised death rates for region A and B from thefollowing.

Age Group	0-10	10-25	25-40	40-60	Above 60
Death per 1000, A (m^A)	2	8	15	32	41
Death per 1000, B(m^B))	4	10	18	28	38
Standard Population (in thousands)	3	12	12	30	50

25. Give brief account on sample registration system.
26. Explain the chief characteristics of an ideally insurable loss exposure.
27. Explain the method of calculating the premium of life insurance. (2 x 10 =20)

BST6B12: OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL

Time: 2 ½ Hours **Max.: 80 Marks**

PART A

Each question carries 2 marks.

1. Define slack and surplus variables.
2. Distinguish between feasible solution and optimal feasible solution
3. Define artificial variable? When do we use it?
4. Define degeneracy in transportation problem.
5. What is meant by North West corner rule in lpp?
6. What are the disadvantages of BIG-M method over two phase method?
7. What are the causes of variation in quality control?
8. Explain the need for quality control techniques in production.
9. Describe C chart.
10. How to read a control chart?
11. What are the difference between defects & defectives?
12. What is the significance of OC curve?
13. Distinguish between consumer's risk and producer's risk.
14. Define LTPD.
15. What are ASN and ATI for the single sampling plan?

Maximum Mark = 25

PART B

Each question carries 5 marks

16. Describe linear programming problem. Write some of its applications.
17. Explain the graphical method for solving linear programming problem.
18. Find a geometrical interpretation and solution as well for the following linear programming problem.

Maximize $Z = 3x_1+5x_2$

Subject to

$$x_1 + 2x_2 \leq 2000$$
$$x_1 + x_2 \leq 1500$$
$$x_2 \leq 600$$
$$x_1 \geq 0 \quad x_2 \geq 0$$

19. Explain assignment problem. Describe any method to solve it.
20. What is meant by a control charts? Explain the applications of these charts.
21. Describe procedure or drawing X bar and R charts.
22. Explain AQL and ASN.
23. Explain the main control charts for attributes and obtain their control limits.

Maximum Mark = 35

PART C

Each question carries 10 marks (Answer any **TWO** Questions)

24. Find the initial basic feasible solution of the following transportation problem. There are four origins three destinations. The availabilities are 9, 10, 8, 7 and the requirements are 17,10,7 respectively.

	A	**B**	**C**
D	2	3	2
E	1	3	4
F	2	3	1
G	2	4	3

25. What are the computational procedures of dual simplex method, explain with an example?
26. Distinguish between double and single sampling plans.
27. Draw the OC curve of the single sampling plan showing the consumers and producers risks.

$2 \times 10 = 20$

ELECTIVE PAPER

BST6E03: RELIABILITY THEORY

Time: 2 hours **Maximum Marks: 60**

Section A

(Each question carries **2** marks)

1. Define the terms: (a) Reliability function R(t) & (b) Hazard function r(t)
2. Define state of a system.
3. What are (a) parallel-series and (b) series-parallel systems?
4. Represent a 3-out-of-3 structure.
5. Define a coherent structure.
6. What do you mean by structural importance of components?
7. Give examples of a series system and a parallel system.
8. Describe the representation of a structure using minimal path sets.
9. Define critical path vector and critical path set.
10. Define Coherent modules.
11. Distinguish between DFR and IFR distributions.
12. Show that the mean of the exponential distribution is the reciprocal of its failure rate.

Maximum Marks = 20

Section B

(Each question carries **5** marks)

13. Define Bridge structure. Represent a bridge structure as parallel-series/series-parallel structure.
14. Explain any one method of computing exact system reliability.
15. Let $h(\underline{p})$ be a system reliability of a coherent system, then show that $h(\underline{p})$ is strictly increasing in each p_i for $0 < p_i < 1$ for all i.
16. Let $\phi(\underline{x})$ be the structure function of a coherent system of order n. Then show that $\prod_{i=1}^{n} x_i \le \phi(\underline{x}) \le \coprod_{i=1}^{n} x_i$.
17. Derive the reliability of a k-out-of-n structure.
18. Show that the hazard function uniquely determines the reliability function.
19. Show that constant hazard function is a characteristic property of exponential distribution .

Maximum Marks = 30

Section C

(Answer **any one** question; each question carries 10 marks)

20. Let ϕ be a coherent structure. Then show that
    (*i*) $\phi(\underline{x} \vee \underline{y}) \ge \phi(\underline{x}) \vee \phi(\underline{y})$ (ii) $\phi(\underline{x}.\underline{y}) \le \phi(\underline{x}).\phi(\underline{y})$
21. Explain inclusion exclusion principle for finding system reliability.

(10x1=10)

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OPEN COURSE BST5D03:
BASIC STATISTICS

Time: 2 hours **Maximum Marks: 60**

Section-A

Each question carries **two** marks

1. Define Census. Write any two of its advantages.
2. What is meant by sampling and non -sampling errors?
3. Define simple random sampling.
4. Distinguish between simple and weighted arithmetic mean.
5. Give four desirable properties of a good average.
6. Define quartile deviation and mean deviation.
7. What is meant by scatter plot?
8. Define the term correlation.
9. What is the principle of least squares?
10. State multiplication theorem of probability.
11. Define random experiment.
12. State the axiomatic definition of probability.

Maximum Marks = 20

Section-B

Each question carries **five** marks

13. State the advantages of sample survey over census.
14. If all observations are not equal. Show that Geometric mean lies between Arithmetic mean and Harmonic mean.
15. Given AM=24.6, Mode=26.1, find the value of the median for a moderately asymmetrical distribution.
16. Explain the absolute measures of dispersion.
17. Explain the principle of least squares for fitting a straight line.
18. State and prove addition theorem of probability of two events.
19. Define frequency definition, classical definition and axiomatic definition of probability.

Maximum Marks = 30

Section-C

Answer ***any one*** question. Each question carries **ten** marks

20. The runs scored by two batsman in 5 innings are given below. Find who is the more consistent.
    A: 74 101 4 82 36 71 14 0 77
    B: 62 5 81 97 22 11 16 1 88
21. Explain (i) conditional probability (ii) multiplication theorem of probability and (iii) independence of three events.

(1 x10 = 10)

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STATISTICS: SYLLABI OF

COMPLEMENTARY COURSES

FOR B.Sc. MATHEMATICS PROGRAMME

CBCSSUG 2022 (2022 admission onwards)

Sem No	Course Code	Course Title	Instructional Hours/week	Credit	Exam Hours	Ratio Ext: Int
1	BST1C01	INTRODUCTORY STATISTICS	4	3	2	4:1
2	BST2C02	PROBABILITY THEORY	4	3	2	4:1
3	BST3C03	PROBABILITY DISTRIBUTIONS AND SAMPLING THEORY	5	3	2	4:1
4	BST4C04	STATISTICAL INFERENCE AND QUALITY CONTROL	5	3	2	4:1

Question Paper Pattern

Question number (From….. To …..)	Type of Questions and Marks
01 to 12	Short answer type carries 2 marks each - 12 questions **(Maximum Marks 20)**
13 to 19	Paragraph/ Problem type carries 5 marks each – 7 questions **(Maximum Marks 30)**
20 to 21	Essay type carries 10 marks (1 out of 2) **(Maximum Mark 10)**
01 to 21	**Total Marks: 60**

SEMESTER I

BST1C01: INTRODUCTORY STATISTICS (CODE: BST1C01)

Contact Hours per week: 4
Number of credits: 3
Number of Contact Hours: 72
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Blue Print for Question Paper Setting / Scrutiny						
Max. Marks: 60						
Question Paper			Syllabus			
Sections or Parts	Mark	Question Numbers	MODULE 1 7 Hrs 7 Marks	MODULE 2 30 Hrs 30 Marks	MODULE 3 15 Hrs 19Marks	MODULE 4 20 Hrs 21 Marks
Expected mark >>>>						
A	2	1	2			
		2		2		
		3		2		
		4		2		
		5		2		
		6		2		
		7		2		
		8			2	
		9			2	
		10				2
		11				2
		12				2
B	5	13	5			
		14		5		
		15		5		
		16			5	
		17			5	
		18			5	
		19				5
C	10	20		10		
		21				10
Actual Mark >> >>			**7**	**32**	**19**	**21**

Question Paper setter has to give equal importance to both theory and problems in section B and C.

1. INTRODUCTORY STATISTICS (CODE: BST1C01)

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Understand the statistical system in India.

CO 2: Learn the basics of data collection and techniques of exploratory data analysis.

CO 3: Familiarize with the basic visualization techniques of data analysis and interpretations.

CO 4: Identify an appropriate relationship between two variables using scatter plot and fitting the same by the method of least squares- straight line, second degree polynomial, power & exponential curves

CO 5. Make the students aware of the areas of time series and index numbers.

Module 1: *Official statistics*: The Statistical system in India: The Central and State Government organizations, functions of the Central Statistical Office (CSO), National Sample Survey Organization (NSSO) and the Department of Economics and Statistics.

7 hours

Module 2: *Introduction to Statistics*: Nature of Statistics, Uses of Statistics, Statistics in relation to other disciplines, Abuses of Statistics. Concept of primary and secondary data. Designing a questionnaire and a schedule. Concepts of statistical population and sample from a population, quantitative and qualitative data, Nominal, ordinal and time series data, discrete and continuous data. Presentation of data by table and bydiagrams, frequency distributions by histogram and frequency polygon, cumulative frequency distributions(inclusive and exclusive methods) and ogives. Measures of central tendency (mean, median, mode, geometricmean and harmonic mean) with simple applications. Absolute and relative measures of dispersion (range,quartile deviation, mean deviation and standard deviation) with simple applications. Co-efficient of variation,Box Plot. Importance of moments, central and non-central moments, and their interrelationships. Measures of skewness based on quartiles and moments; kurtosis based on moments.

30 hours

Module 3: *Correlation and Regression:* Scatter Plot, Simple correlation, Simple regression, two regression lines, regression coefficients. Fitting of straight line, parabola, exponential, polynomial (least square method).

15 hours

Module 4: *Time series*: Introduction and examples of time series from various fields, Components of times series, Additive and Multiplicative models. Trend: Estimation of trend by free hand curve method, method of semi averages, method of moving averages and fitting various mathematical curves. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.

Index numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's.

20 hours

References:

1. S.C. Gupta and V.K. Kapoor. *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nded. Revised reprint, Books and Allied
4. Hoel P.G. *Introduction to mathematical statistics*, Asia Publishing house.
5. Chatfield.C. *The Analysis of Time Series: An Introduction*, Chapman & Hall
6. *Guide to current Indian Official Statistics*, Central Statistical Office, GOI, New Delhi.
7. www.mospi.gov.in
8. www.ecostat.kerala.gov.in

SEMESTER II

BST2C02: PROBABILITY THEORY

Contact Hours per week: 4
Number of credits: 3
Number of Contact Hours: 72
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Blue Print for Question Paper Setting / Scrutiny						
Max. Marks: 60						
Question Paper			Syllabus			
Sections or Parts	Mark	Question Numbers	MODULE 1 25Hrs 28 Marks	MODULE 2 12Hrs 16 Marks	MODULE 3 15 Hrs 16 Marks	MODULE 4 20 Hrs 19 Marks
Expected mark >>>>						
A	2	1	2			
		2	2			
		3	2			
		4	2			
		5		2		
		6		2		
		7		2		
		8			2	
		9			2	
		10			2	
		11				2
		12				2
B	5	13	5			
		14	5			
		15		5		
		16		5		
		17			5	
		18			5	
		19				5
C	10	20	10			
		21				10
Actual Mark >> >>			**28**	**16**	**16**	**19**

Question Paper setter has to give equal importance to both theory and problems in section B and C.

II. PROBABILITY THEORY (BST2C02)

Course Outcomes: *After successful completion of the course, students will be able to:*

CO1: Understand the concept of probability and its applications

CO2: Understand the basic concepts about random variables and its properties

CO3: Learn the random variables in two-dimension and their properties.

Module 1: *Introduction to Probability:* Random experiment, Sample space, events, classical definition of probability, statistical regularity, field, sigma field, axiomatic definition of probability and simple properties, addition theorem (two and three events), conditional probability of two events, multiplication theorem, independence of events-pair wise and mutual, Bayes theorem and its applications.

25 hours

Module 2: *Random variable*s: Discrete and continuous, probability mass function (pmf) and probability density function (pdf)-properties and examples, Cumulative distribution function and its properties, change of variables (univariate case only).

12 hours

Module 3: *Mathematical expectations (univaraite):* Definition, raw and central moments (definition and relationships), moment generation function and properties, characteristic function (definition and use only), skewness and kurtosis using moments.

15 hours

Module 4: *Bivariate random variables*: Joint pmf and joint pdf, marginal and conditional probability, independence of random variables, function of random variable. Bivariate expectations, conditional mean and variance, covariance, correlation coefficient, independence of random variables based on expectation.

20 hours

References :

1. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
2. S.C.Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. John E Freund, *Mathematical Statistics*, Pearson Edn, New Delhi
5. Hoel P.G. *Introduction to mathematical statistics*, Asia Publishing house.

SEMESTER III

BST3C03- PROBABILITY DISTRIBUTIONS AND SAMPLING THEORY

Contact Hours per week: 5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Blue Print for Question Paper Setting / Scrutiny						
Max. Marks: 80						
Question Paper			Syllabus			
Sections or Parts	Mark	Question Numbers	MODULE 1	MODULE 2	MODULE 3	MODULE 4
			30Hrs	25Hrs	10Hrs	25 Hrs
			28 Marks	21 Marks	9 Marks	21 Marks
Expected mark >>>>						
A	2	1	2			
		2	2			
		3	2			
		4	2			
		5		2		
		6		2		
		7		2		
		8			2	
		9			2	
		10				2
		11				2
		12				2
B	5	13	5			
		14	5			
		15		5		
		16		5		
		17		5		
		18			5	
		19				5
C	10	20	10			
		21				10
Actual Mark >> >>			**28**	**21**	**9**	**21**

Question Paper setter has to give equal importance to both theory and problems in section B and C.

III. PROBABILITY DISTRIBUTIONS AND SAMPLING THEORY (CODE: BST3C03)

Course Outcomes: *After successful completion of the course, students will be able to:*

CO1: Understand the applications of theoretical discrete distributions
CO2: Learn the concept of convergence of sequence of random variables, law of large numbers and central limit theorem.
CO3: Categorize and defines various sampling methods
CO4: Identifies and derives the important sampling distributions.

Module 1: *Standard distributions:* Discrete type-Bernoulli, Binomial, Poisson, Geometric, Negative Binomial (definition only), Uniform (mean, variance and mgf).
Continuous type-Uniform, exponential and Normal (definition, properties and applications); Gamma (mean, variance, mgf); Lognormal, Beta, Pareto and Cauchy (Definition only)

30 hours

Module 2: *Limit theorems:* Chebyshev's inequality, Sequence of random variables, parameter and Statistic, Sample mean and variance, Convergence in probability (definition and example only), weak law of large numbers (iid case), Bernoulli law of large numbers, Convergence in distribution (definition and examples only), Central limit theorem (Lindberg levy-iid case)

25 hours

Module 3: Sampling methods: Simple random sampling with and without replacement, systematic sampling (Concept only), stratified sampling (Concept only), Cluster sampling(Concept only)

10 hours

Module 4: Sampling distributions: Statistic, Standard error, Sampling from normal distribution, distribution of sample mean, sample variance, chi-square distribution, t- distribution, and F distribution (definition, derivations and relationships only).

25 hours

References:

1. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
2. S.C.Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. John E Freund, *Mathematical Statistics*, Pearson Edn, NewDelhi
5. Cochran W.G. (1984):Sampling Techniques(3rdEd.), Wiley Eastern.

SEMESTER IV

BST4C04 - STATISTICAL INFERENCE AND QUALITY CONTROL

Contact Hours per week: 5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Blue Print for Question Paper Setting / Scrutiny						
Max. Marks: 60						
Question Paper			Syllabus			
Sections or Parts	Mark	Question Numbers	MODULE 1	MODULE 2	MODULE 3	MODULE 4
			30 Hrs	35 Hrs	10 Hrs	15Hrs
			26 Marks	30Marks	9 Marks	14 Marks
Expected mark >>>>						
A	2	1	2			
		2	2			
		3	2			
		4		2		
		5		2		
		6		2		
		7		2		
		8		2		
		9			2	
		10			2	
		11				2
		12				2
B	5	13	5			
		14	5			
		15		5		
		16		5		
		17			5	
		18				5
		19				5
C	10	20	10			
		21		10		
Actual Mark >> >>			**26**	**30**	**9**	**14**

Question Paper setter has to give equal importance to both theory and problems in section B and C.

IV: STATISTICAL INFERENCE AND QUALITY CONTROL. (CODE: BST4C04)

Course Outcomes: *After successful completion of the course, students will be able to:***:**

CO 1: Equip the students with the theory essential for estimation of unknown parameters.
CO 2: Describe the criteria of good estimators
CO 3: Defines the Cramer Rao inequality, MVU estimators and MVB estimators.
CO 4: Understand the concepts of testing of hypotheses
CO 5: Identify and apply the small sample and large sample tests
CO 6: Equip the students with preliminary ideas and techniques of control charts

Module 1: *Estimation theory*: Parametric space, sample space, point estimation. Neyman Factorization criteria, Requirements of good estimator: Unbiasedness, Consistency, Efficiency, Sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality (definition only). Minimum Variance Bound (MVB) estimators.
Methods of estimation: Maximum likelihood estimation and Moment estimation methods (Detailed discussion with problems); Properties of maximum likelihood estimators (without proof); Least squares and minimum variance (concepts only).
Interval estimation: Confidence interval (CI);CI for mean and variance of Normal distribution; Confidence interval for binomial proportion and population correlation coefficient when population is normal.

30 hours

Module 2: *Testing of Hypothesis*: Level of significance, Null and Alternative hypotheses, simple and composite hypothesis ,Types of Errors, Critical Region, Level of Significance, Power and p-values. Most powerful tests, Neyman-Pearson Lemma (without proof), Uniformly Most powerful tests. Large sample tests: Test for single mean, equality of two means, Test for single proportion, equality of two proportions. Small sample tests: t-test for single mean, unpaired and paired t-test.
F test for equality of variances, Chi-square test for goodness of fit, test of independence and association of attributes. Testing means of several populations: One Way ANOVA, Two Way ANOVA (assumptions, hypothesis, ANOVA table and problems)

35 hours

Module 3: *Non-parametric methods***:** Advantages and drawbacks; Test for randomness, Median test, Sign test, Mann-Whiteny U test and Wilcoxon test; Kruskal Wallis test (Concept only)

10 hours

Module 4: *Quality Control:* General theory of control charts, causes of variations in quality, control limits, sub-grouping, summary of out-of-control criteria. Charts of variables - X bar chart, R Chart and sigma chart. Charts of attributes – c-charts, p-chart and np-chart.(Concepts and problems).

15 hours

References:

1. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
2. Gupta, S.P. *Statistical Methods*. Sultan Chand and Sons: New Delhi.
3. S.C.Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons
4. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rdEdn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
5. John E Freund, *Mathematical Statistics*, Pearson Edn, NewDelhi
6. Grant E L, *Statistical quality control*, McGraw Hill
7. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

Statistics: Model Question Papers of Complementary Courses (For B.Sc, Mathematics Programme)

First Semester B.Sc. (Mathematics) Degree Examination
Model Question paper
Statistics- Complementary
BST1C01- INTRODUCTORY STATISTICS

Time: 2 Hours **Maximum Marks: 60**

Part A
Each question carries 2 Marks.
Maximum Marks that can be scored in this Part is 20

1. What are the main roles of State level statistical organizations?
2. What are the main functions of Statistics?
3. What are ogives? What are its uses?
4. Show that GM of a set of positive observation lies between AM and HM.
5. What do you mean by partition values?.
6. Calculate median for the following data

Class:	0-5	5-10	10-15	15-20	20-25
f :	5	10	15	12	8

7. Compare range and quartile deviation.
8. Define correlation and regression.
9. Write down the normal equations to fit a straight line $y = a + bx$.
10. What are the components of time series?
11. Write down an additive and a multiplicative model of a time series with the components T, S, C and I.
12. Give the formula for Fisher's ideal index.

Part B
Each question carries 5 Marks.
Maximum Marks that can be scored in this Part is 30

13. Explain the important activities of Central Statistics Organization.
14. Distinguish between primary data and secondary data.
15. Draw less than ogive and more than ogive and obtain median.

Class:	0-10	10-20	20-30	30-40	40-50	50-60	60-70
f :	5	12	28	40	21	10	4

16. Define rth central moment and express it in terms of the raw moments of order r or less.
17. Explain the principle of least squares method of fitting of a second degree curve of the form $y = a + bx + cx^2$ for n pairs of values.
18. Show that coefficient of correlation lies in between -1 and +1.
19. Fit an exponential trend to the following time series

Year :	1990	1991	1992	1993	1994	1995
Values :	2	3	4	6	9	13

Part C
Answer any one question and carries 10 Marks.

20. (a) Show that mean deviation is a minimum when calculated from the median.
    (b) The runs scored by batsman in 5 innings are given. Find the score consistent batsman.

A:	25	50	45	30	70
B:	10	70	50	20	95

21. What are index numbers? Briefly discuss the problems in construction of index numbers.

Second Semester B.Sc. (Mathematics) Degree Examination
Model Question Paper
Statistics- Complementary
BST2C02- PROBABILITY THEORY

Time: 2 Hours **Maximum Marks: 60**

Part A

Each question carries 2 Marks.

Maximum Marks that can be scored in this Part is 20

1. Define the terms random experiment and sample space.
2. What are the axioms of probability theory?
3. State and prove the addition theorem of probability.
4. Define Conditional probability.
5. What is relationship between distribution function and density function?
6. Define discrete and continuous random variables.
7. Let X be a continuous random variable pdf f(x) then find the pdf of $Y = X^2$.
8. If X and Y are two random variables, show that E(X +Y) = E(X)+E(Y).
9. Find the characteristic function of f(x) = a exp (-ax), a > 0, x > 0.
10. Define joint distribution and marginal distribution of a random variables.
11. Define conditional mean and conditional variance in discrete case.
12. Prove that $-1 \leq \rho_{xy} \leq +1$.

Part B

Each question carries 5 Marks.

Maximum Marks that can be scored in this Part is 30

13. State and prove Baye's theorem and indicate its importance.
14. If A, B, C are pair wise independent and A is independent of BUC then show that A, B, C are mutually independent.
15. A continuous random variable X has the following density function,

$$f(x) = \begin{cases} ax, & 0 \leq x \leq 1 \\ a, & 1 \leq x \leq 2 \\ -ax+3a, & 2 \leq x \leq 3 \\ 0, & \text{elsewhere} \end{cases}$$

(a) Find the constant a
(b) Determine the distribution function.
(c) Sketch the graphs of f(x) and F(x).
(d) If three independent observations are made what is the probability that exactly one of them is larger than 1.5.

16. If X has the pdf then $f(x) = \frac{1}{\sqrt{2\pi}} \exp\left[-\frac{x^2}{2}\right]$, $-\infty < X < \infty$. Find the density function of $Y = X^2$.
17. Define a probability density function and state its properties.
18. If the probability density of X is defined by $f(x) = C \exp(-ax)$, $0 \leq x \leq \infty$, $a>0$. Find the value of C. Also find the first three moments.
19. Find the mean and standard deviation of a random variable X with pdf $f(x) = 6x(1 - x)$; $0 < x < 1$.

Part C

Answer any one question and carries 10 Marks.

20. For events A1, A2, ...An show that
(a) $P(A1A2 .....An) \geq \sum_{i=1}^{n} P(Ai) - (n - 1)$
(b) $P(A1UA2U ..... U An) \leq \sum_{i=1}^{n} P(Ai)$.
21. If X and Y have the joint pdf given by $f(x; y) = \frac{x+y}{21}$; x= 1,2,3; y=1,2. Obtain
(a) (b) E(X/Y=2) and (c) V(X/Y=2).

III Semester B.Sc. (Mathematics) Degree Examination
Model Question Paper
Statistics (Complementary)
BST3C03-PROBABILITY DISTRIBUTIONS AND SAMPLING THEORY

Time: 2 hours Max. Marks: 60

SECTION-A
Each question carries 2 Marks.
Maximum Marks that can be scored in this section is 20.

1. Describe Poisson distribution.
2. Define Binomial random variable.
3. Derive the mean of a discrete uniform random variable.
4. Find the mgf of Geometric distribution.
5. Define convergence in probability.
6. Define convergence in distribution.
7. State Lindberg-Levy central limit theorem.
8. Define simple random sampling with replacement.
9. What do you mean by cluster sampling?
10. Define F statistic. What is its probability density function?
11. What is meant by sampling distribution?
12. Write down the probability density function of 3^2distribution.

SECTION-B
Each question carries 5 Marks.
Maximum Marks that can be scored in this section is 30.

13. State and prove memory less property of exponential distribution.
14. Find the mean and variance of Gamma distribution.
15. State the weak law of large numbers. Examine if WLLN is satisfied by the following sequence of random variables *X_n+ where n = 1, 2, ... and $X_n = \pm\sqrt{2n-1}$ with probability $\frac{1}{2}$
16. State and prove Chebychev's inequality.
17. A **r**andom variable takes the values -1, 1, 3, 5 with probabilities $\frac{1}{6}, \frac{1}{6}, \frac{1}{6}$ $\frac{1}{2}$ respectively. Find an upper bound for $(|X-3|) \geq 1$.
18. Distinguish between systematic sampling and stratified sampling.
19. Establish the relationship between t, F and χ^2 distribution.

SECTION-C
(Answer *any one* Question and carries 10 marks)

20. (a) Derive the moment generating function of Normal random variable.

    (b) Show that the even order central moments of the Normal distribution with parameters μ and σ^2 is

    $$(x-\mu)^{2n} = ,(2n-1)(2n-3) \ldots 3.1\text{-}\sigma^{2n}$$

21. Derive the distribution of sample mean $\overline{X}$ and sample variance S^2 when X~ N(μ, σ^2).

IV Semester B.Sc. Degree (Mathematics) Examination
Model Question Paper
Statistics (Complementary)
BST4C04 – STATISTICAL INFERENCE AND QUALITY CONTROL

Time : **2** hours Max Marks : **60**

Part A

Each question carries **2** marks

1. Distinguish between point estimation and interval estimation.
2. Write any four properties of Maximum likelihood estimator.
3. Give sufficient conditions for the existence of a consistent estimator and illustrate with an example.
4. Distinguish between simple and composite hypothesis.
5. State Neyman Pearson lemma.
6. Write down the test statistic used in paired t test and mention its distribution.
7. How do you conduct chisquare test of goodness of fit?
8. Explain the test used for testing the equality of variances of two normal populations.
9. Define run. Find the number of runs in the sequence HHHHTTHHTTTHHTTTTHH.
10. What are the drawbacks of nonparametric methods?
11. Distinguish between control charts of variables and that of attributes.
12. What is the theme behind the use of R-chart in statistical quality control?

Max marks =**20**

Part B

Each question carries **5** marks

13. Define a consistent estimator. If t is a consistent estimator of θ, show that t^2 is a consistent estimator of θ^2.
14. Explain the method of constructing confidence interval for variance when a random sample is taken from Normal population.
15. Explain (i) Null and alternative hypothesis
    (ii) Type I and Type II errors
    (iii) Most powerful test.
16. Two samples of people consisting of 400 and 500 individuals have mean heights 171.3 and 165.3 cms. with variances 40 and 37.5 respectively. Examine whether the populations from which the samples are taken have the same mean?
17. Write a short note on Kruskal Wallis test.
18. How do you set the control limits for sigma chart?
19. How can one decide the sample size for fraction defective charts?

Max marks =**30**

Part C

Each question carries **10** marks (Answer any **one** question)

20. Explain the method of maximum likelihood estimation (m.l.e). Also find the m.l.e for the parameter θ when $f(x,\theta) = \frac{1}{2\theta}$, $-\theta < x < \theta$.
21. Find the size and power of the following test. Reject $H_0 : \lambda = 1$ in favour of $H_1 : \lambda = 2$ whenever $X_1 + X_2 \geq 2$. Assume that X_1 and X_2 are independent observations from Poisson (λ) distribution.

STATISTICS: SYLLABI OF COMPLEMENTARY COURSES

FOR B. Sc. PSYCHOLOGY PROGRAMME

CBCSSUG 2022 (2022 admission onwards)

Sem No	Course Code	Course Title	Instructional hours/ week	Credit	Exam Hours	Ratio Ext: Int
1	BST1C05	**DESCRIPTIVE STATISTICS**	4	3	2	4:1
2	BST2C06	**REGRESSION ANALYSIS AND PROBABILITY THEORY**	4	3	2	4:1
3	BST3C07	**PROBABILITY DISTRIBUTIONS AND PARAMETRIC TESTS**	5	3	2	4:1
4	BST4C08	**STATISTICAL TECHNIQUES FOR PSYCHOLOGY**	5	3	2	4:1

STATISTICS: SYLLABI OF COMPLEMENTARY COURSES
FOR B.Sc. PSYCHOLOGY PROGRAMME
SEMESTER 1:
BST1C 05- DESCRIPTIVE STATISTICS

Contact Hours per week: *4*
Number of credits: *3*
Number of Contact Hours: *72*
Course Evaluation: *External 60 Marks+ Internal 15 Marks*
Duration of Exam: *2 Hours*

Question Paper Pattern

Type of Questions	Question number (From….. To …..)	Marks
Short Answer	01 to 12	Short answer type carries 2 marks each - 12 questions **(Maximum Marks 20)**
Paragraph/ Problems	13 to 19	Paragraph/ Problem type carries 5 marks each – 7 questions **(Maximum Marks 30)**
Essay	20 to 21	Essay type carries 10 marks (1 out of 2) **(Maximum Marks 10)**
Total	**01 to 21**	**60**

Question Paper setter has to give equal importance to both theory and problems in sections B and C.

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Generate interest in Statistics.
CO 2: Equip the students with the concepts of basic Statistics.
CO 3: Develop basic knowledge about Statistical methods.

Module 1: *A basic idea about data*- collection of data, primary and secondary data, organization, planning of survey and diagrammatic representation of data.

10 Hours

Module 2: *Classification and tabulation*- Classification of data, frequency distribution, formation of a frequency distribution, Graphic representation *viz*. Histogram, Frequency Curve, Polygon, Ogives, Bar diagram and Pie diagram

10 Hours

Module 3: *Measure of central tendency*- Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean, Combined Mean, Advantages and disadvantages of each average.

20 Hours

Module 4: *Measures of dispersion*- Range, Quartile Deviation, Mean Deviation, Standard Deviation, Combined Standard Deviation, Percentiles, Deciles, Relative Measures of Dispersion, Coefficient of variation.

16 Hours

Module 5: *Skewness and Kurtosis*- Pearson's and Bowley's coefficient of skewness, Percentile Measure of Kurtosis.

16 Hours

References

1. Gupta, S.P. *Statistical Methods*. Sultan Chand and Sons: New Delhi.

2. Gupta, S.C., & Kapoor, V.K. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand and Sons.

3. Garret, H.E., &Woodworth, R.S. *Statistics in Psychology and Education*. Bombay: Vakila, Feffex and Simens Ltd.

4. Mood, A.M., Graybill, F.A and Boes, D.C. *Introduction to Theory of Statistics*. 3rd Edition Paperback – International Edition.

5. Mukhopadhyay,P. *Mathematical Statistics.* New central Book Agency (P) Ltd: Calcutta.

SEMESTER II

BST2C06- REGRESSION ANALYSIS AND PROBABILITY THEORY

Contact Hours per week: *4*
Number of credits: *3*
Number of Contact Hours: *72*
Course Evaluation: *External 60 Marks+ Internal 15 Marks*
Duration of Exam: *2 Hours*

Question Paper Pattern

Type of Questions	Question number (From….. To …..)	Marks
Short Answer	01 to 12	Short answer type carries 2 marks each - 12 questions **(Maximum Marks 20)**
Paragraph/ Problems	13 to 19	Paragraph/ Problem type carries 5 marks each – 7 questions **(Maximum Marks 30)**
Essay	20 to 21	Essay type carries 10 marks (1 out of 2) **(Maximum Marks 10)**
Total	**01 to 21**	**60**

Question Paper setter has to give equal importance to both theory and problems in sections B and C.

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Understand the concept of bivariate data and correlation analysis.
CO 2: Learn the concept of regression and it applications in psychology.
CO 3: Learn the concept of probability and its properties.
CO 4: Understand the concept of random variables and its probability distributions.

Module 1: *Bivariate data*- relationship of variables, correlation analysis**,** methods of studying correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Calculation of Correlation from a 2-way table, Interpretation of Correlation Coefficient, Rank Correlation

11 Hours

Module 2: *Regression analysis*- linear regression, Regression Equation, Identifying the Regression Lines properties of regression coefficients, numerical problems

9 Hours

Module 3: *Partial and Multiple Correlation Coefficients*- Multiple Regression Equation, Interpretation of Multiple Regression Coefficients (three variable cases only)

16 Hours

Module 4: *Basic probability*- Sets, Union, Intersection, Complement of Sets, Sample Space, Events, Classical, Frequency and Axiomatic Approaches to Probability, Addition and Multiplication Theorems, Independence of Events (Up-to three events)

20 Hours

Module 5: *Random Variables and their probability distributions*- Discrete and Continuous Random Variables, Probability Mass Function, Distribution Function of a Discrete Random Variable. 16 Hours

References:

1. Gupta, S.P. *Statistical Methods*. Sultan Chand and Sons: New Delhi.

2. Gupta, S.C., &Kapoor, V.K. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand and Sons.

3. Garret, H.E., &Woodworth, R.S. *Statistics in Psychology and Education*. Bombay: Vakila, Feffex and Simens Ltd.

4. Mood, A.M., Graybill, F.A and Boes, D.C. *Introduction to Theory of Statistics*. 3rd Edition Paperback – International Edition.

5. Mukhopadhyay, P. *Mathematical Statistics.* New central Book Agency (P) Ltd: Calcutta.

SEMESTER III

BST3C07- PROBABILITY DISTRIBUTIONS AND PARAMETRIC TESTS

Contact Hours per week: 5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Question Paper Pattern

Type of Questions	Question number (From….. To …..)	Marks
Short Answer	01 to 12	Short answer type carries 2 marks each - 12 questions **(Maximum Marks 20)**
Paragraph/ Problems	13 to 19	Paragraph/ Problem type carries 5 marks each – 7 questions **(Maximum Marks 30)**
Essay	20 to 21	Essay type carries 10 marks (1 out of 2) **(Maximum Marks 10)**
Total	**01 to 21**	**60**

Question Paper setter has to give equal importance to both theory and problems in sections B and C.

Course Outcomes: *After successful completion of the course, students will be able to:*
CO1: Understand various probability distributions
CO2: Learn different sampling methods
CO3: Familiarize different Statistical tests and its applications in psychology

Module 1: *Distribution Theory*- Binomial, Poisson and Normal Distributions, Mean and Variance (without derivations), Numerical Problems, Fitting, Importance of Normal Distribution, standard normal distribution, simple problems using standard normal tables, Central Limit Theorem (Concepts only).

25 Hours

Module2: *Methods of Sampling*- Random Sampling, Simple Random Sampling, Stratified, Systematic and Cluster Sampling, Non Random sampling, Subjective sampling, Judgment sampling and convenience sampling.

20 Hours

Module 3: *Fundamentals of Testing*- Type-I & Type-II Errors, Critical Region, Level of Significance, Power, *p* value, Tests of Significance

15 Hours

Module 4: *Large Sample Tests* – Test of a Single, Mean Equality of Two Means, Test of a Single Proportion, and Equality of Two Proportions.

10 Hours

Module 5: *Small Sample tests*-Test of a Single Mean, Paired and Unpaired t-Test, Chi-Square Test of Variance, F-Test for the Equality of Variance, Tests of Correlation

20 Hours

References

1. Gupta, S.P. *Statistical Methods*. Sultan Chand and Sons: New Delhi.
2. Gupta, S.C., &Kapoor, V.K. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand and Sons.
3. Garret, H.E., &Woodworth, R.S. *Statistics in Psychology and Education*. Bombay: Vakila, Feffex and Simens Ltd.
4. Mood, A.M., Graybill, F.A and Boes, D.C. *Introduction to Theory of Statistics*. 3rd Edition Paperback – International Edition.
5. Mukhopadhyay, P. *Mathematical Statistics.* New central Book Agency (P) Ltd: Calcutta.

SEMESTER IV

BST4C08- STATISTICAL TECHNIQUES FOR PSYCHOLOGY

Contact Hours per week: 5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Question Paper Pattern

Type of Questions	Question number (From… To...)	Marks
Short Answer	01 to 12	Short answer type carries 2 marks each - 12 questions **(Maximum Marks 20)**
Paragraph/ Problems	13 to 19	Paragraph/ Problem type carries 5 marks each – 7 questions **(Maximum Marks 30)**
Essay	20 to 21	Essay type carries 10 marks (1 out of 2) **(Maximum Marks 10)**
Total	**01 to 21**	**60**

Question Paper setter has to give equal importance to both theory and problems in sections B and C.

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Make the students aware of analysis of variance and non-parametric Statistical tests in different areas of Psychology
CO 2: Familiarize with basic designs of experiments
CO 3: Develop skills about applications of Statistics in different areas of Psychological studies.
CO 4: Skill in preparing questionnaires

Module 1: *Analysis of Variance*- assumptions, One-way and Two-way Classification with Single Observation per Cell, Critical Difference.

20 Hours

Module 2: *Non Parametric tests*- Chi-square Test of Goodness of Fit, Test of Independence of Attributes, Test of Homogeneity of Proportions**.**

20 Hours

Module 3: *Sign Test*- Wilcoxon's Signed Rank Test, Wilcoxon's Rank Sum Test, Run Test and Kruskal-Wallis Test.

20 Hours

Module 4: *Factorial Design*- Basics of factorial Design, Factorial experiments and their uses in Psychological studies, Concepts of factorial experiments (without derivation), simple problems.

15 Hours

Module 5: *Preparation of Questionnaire*- Scores and Scales of Measurement, Reliability and Validity of Test Scores.

15 Hours

References

1. Gupta, S.P. *Statistical Methods*. Sultan Chand and Sons: New Delhi.
2. Gupta, S.C., &Kapoor, V.K. *Fundamentals of Applied Statistics*. New Delhi: Sultan Chand and Sons.
3. Garret, H.E., &Woodworth, R.S. *Statistics in Psychology and Education*. Bombay: Vakila, Feffex and Simens Ltd.
4. Mood, A.M., Graybill, F.A and Boes, D.C. *Introduction to Theory of Statistics*. 3rd Edition Paperback – International Edition.
5. Douglas C. Montgomery. *Design and Analysis of Experiments.* 9th Edition.

STATISTICS- MODEL QUESTION PAPERS FOR B.Sc. PSYCHOLOGY PROGRAMME

FIRST SEMESTER B. Sc. DEGREE (Psychology) EXAMINATION

Statistics- Complementary

BST1C05–DESCRIPTIVE STATISTICS

Time: 2 Hours **Max Marks: 60**

SECTION-A

Each question carries 2 Marks.

Maximum Marks that can be scored in this section is 20.

1. Compare less than and greater than Ogives.
2. What do you mean by percentiles?
3. Define geometric mean
4. What is the variance of the observations 8, 10, 12?
5. How will you find range of a grouped frequency distribution?
6. What is meant by relative measure of dispersion?
7. Define quartile deviation
8. Distinguish between discrete and continuous data. Give examples
9. The average pulse rate of 40 males was found to be 78 and that of a group of 60 females was 69. Find the combined mean pulse rate of the 100 patients.
10. What is combined standard deviation?
11. What are the advantages of median?
12. Draw a bar diagram depicting the following data

Year	1992	1993	1994	1995
Export (in crore)	55	63	60	70

SECTION-B

Each question carries 5 Marks.

Maximum Marks that can be scored in this section is 30.

13. Explain Kurtosis. What are the different types of Kurtosis?
14. Discuss the graphical methods used for representing afrequency distribution
15. The blood serum cholesterol levels of 10 patients are given below. Calculate the S.D. and C.V.

    220, 230, 240, 250, 260, 270, 280, 255, 265, 290
16. Write the importance of diagrams and graphs for data analysis
17. Define classification. What are the different types of classification?
18. Explain Quartile deviation. What are the advantages and disadvantages of quartile deviation?
19. Calculate AM and SD for the following data

Class	10-14	14-18	18-22	22-26	26-30
frequency	20	30	11	3	5

SECTION-C

(Answer *any one* Question and carries 10 marks)

20. Calculate the mean deviation about the mean for the given data.

Class	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Frequency	4	8	12	15	12	6	3

21.21.

(a) Define Skewness. What are the different types of Skewness?

(b) Calculate Karl Pearson's Coefficient of skewness forthe following frequency distribution

Class	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104
frequency	8	15	18	25	14	9	6	5

SECOND SEMESTER B. Sc. DEGREE (Psychology) EXAMINATION

Statistics- Complementary BST2C06–

REGRESSION ANALYSIS AND PROBABILITY THEORY

Time: 2 Hours **Max Marks: 60**

SECTION-A

Each question carries 2 Marks.

Maximum Marks that can be scored in this section is 20.

1. Define Spearman's rank correlation coefficient
2. Distinguish between discrete and continuous variables
3. What is meant by a scatter diagram?
4. State the Multiplication theorem of probability for two events
5. Define probability mass function
6. Define sample space. Give one example
7. Define the following
   (a) Disjoint set
   (b) Universal set
   (c)Null set
8. If $P(A)=0.2, P(B)=0.6, P(A\cap B)=0.3$,then $P(AUB)=$ ----------
9. If $f(x) = kx, x = 1.2.3. \ldots$ and zero elsewhere is a p.m.f. Find $P(X \geq 2.5)$..
10. If $_{12} = 0.93,\ _{13} = 0.99$ $_{23} = 0\ 92.$ Calculate $_{12.3}$.
11. Consider the following p.m.f

x	1	0	2
$f(x)$	k	$2k$	$3k$

Find the value of k .

12. Distinguish between mutually exclusive events and mutually exhaustive events

SECTION-B

Each question carries 5 Marks.

Maximum Marks that can be scored in this section is 30.

13. Distinguish between partial correlation and multiple correlations
14. What is meant by linear regression? What are two regression lines?Give their equations
15. Explain the different approaches to the theory of probability.
16. State addition theorem in probability. A problem in mathematics is given two students A and B. Whose chances of solving it are 1/3 and 2/3 respectively. What is the probability that the problem will besolved?
17. If σ_x=6 , σ_y=10 and $\text{cov}(x, y)$ = -30, find the correlation between X and Y. Comment on the same. Also find the regression coefficients.
18. In a box there are 8 white, six blue and 10 pink balls. If 3 balls are drawn at random from the box, what is the probability that

a. Two balls are white

b. None of 3 is pink

c. 3 balls are blue

19. Define the distribution function of a discrete random variable. Alsowrite its properties

SECTION-C

(Answer *any one* Question and carries 10 marks)

20. A random variable X has the following probability function

x	-1	0	2
$f(x)$	k	$2k$	$3k$

a. Determine the value of k

b. Find $P(X<2)$ and $P(X\leq 2)$

c. Write down the distribution function of X

21. (i) State the important properties of Karl Pearson's coefficient of correlation.

(ii) Calculate the correlation coefficient for the following data

X	7	15	13	3	10	12
Y	27	45	51	9	33	51

THIRD SEMESTER B. Sc. DEGREE (Psychology) EXAMINATION

Statistics- Complementary

BST3C07– PROBABILITY DISTRIBUTIONS AND PARAMETRIC TESTS

Time: 2 Hours **Max Marks: 60**

SECTION-A

Each question carries 2 Marks.

Maximum Marks that can be scored in this section is 20.

1. What is meant by a Statistical test? Give an example
2. Write down the test Statistic for testing the equality of means of two normal population whose variance are equal and when the sample sizes are small
3. Distinguish between Null and Alternative hypothesis
4. Give two instances where binomial distribution can be applied
5. What is sampling frame?
6. What is convience sampling?
7. Define sampling distribution
8. A binomial distribution has n=500 and p=0.1. Find the mean and variance of this distribution
9. State central limit theorem
10. Define power of a test
11. What is standard error
12. Write down the p.d.f of standard normal distribution

SECTION-B

Each question carries 5 Marks.

Maximum Marks that can be scored in this section is 30.

13. What are the main features of Normal distribution
14. If 3% electric bulbs manufactured by a company are defective. Find the probability that in a sample of 100 bulbs, exactly five bulbs are defective (*Given* e^{-3}=0 . 0492)
15. Describe Paired sample t test
16. Distinguish between systematic sampling and stratified sampling.
17. A sample of 25 items were taken from a population with SD 10 and the sample mean is found to be 65. Can it be regarded as a sample from a normal population with meanμ=60. (use α =5)
18. The customer accounts at a certain departmental store have an average balance of Rs. 120 and SD of Rs. 40. Assume that the account balance are normally distributed
    (a) What proportion of the accounts as over Rs. 150
    (b) What proportion of accounts in between Rs. 100 and Rs. 150
19. Sample sizes 10 and 18 taken from two normal population gave standard deviation 14 and 20 respectively. Test the hypothesis that the samples have come from population with the same standard deviation at 5% level of significance

SECTION-C

(Answer *any one* Question and carries 10 marks)

20. Explain the test procedure for test the equality of variance of two normal populations with known mean
21. The screws produced by certain machine were checked by examining samples. The following table shows the distribution of 128 sample according to the number of defective items they contained

No. of defective	0	1	2	3	4	5	6	7	Total
No of samples	7	6	19	35	30	23	7	1	128

Fit a binomial distribution to the data

FOURTH SEMESTER B. Sc. DEGREE (Psychology) EXAMINATION
Statistics- Complementary
BST4C08– STATISTICAL TECHNIQUES FOR PSYCHOLOGY

Time: 2 Hours **Max Marks: 60**

SECTION-A
Each question carries 2 Marks.
Maximum Marks that can be scored in this section is 20.

1. What is meant by validity
2. What are contingency tables
3. Write down the test statistic of chi- square test for testing homogeneity
4. What are the advantages of non- parametric test
5. What is meant by Ratio scale
6. State three assumptions of ANOVAtechnique
7. State the null hypothesis of one way ANOVA
8. Define the term reliability
9. Write down the test statistic of chi- square test for testing goodness of fit
10. What is meant by interval scale
11. Write any three assumptions associated with non parametric test
12. What do you mean by pilot survey

SECTION-B
Each question carries 5 Marks.
Maximum Marks that can be scored in this section is 30.

13. What are the steps in preparing a questionnaire?
14. Write a short note on Krushkal- Wallis test
15. Describe the importance of factorial experiments in psychological studies
16. Briefly explain Wilcoxon's Rank sum test
17. The following are the marks obtained by 10 students in a certain examination

    Marks: 43 48 65 57 31 60 37 48 78 59
    Test the hypothesis that population variance is 100 (Test at 5% level of significance)

18. The following data give the number of lesions on halves of eight tobacco leaves

Pair number	1	2	3	4	5	6	7	8
Proportion 1, X_1	31	20	18	17	9	8	10	7
Proportion 2, X_2	18	17	14	11	10	7	5	6

    Use Wilcoxon's signed rank test to test whether the two samples are significantly different
19. Explain the chi- square test for independence of attribute

SECTION-C
(Answer *any one question and* carries 10 marks)

20. A trucking company wishes to test the average life of each of the three brands of tyres. The company uses all branches on randomly selected trucks. The records showing the lives (thousands of miles) of tyres are as given. Using ANOVA, test the hypothesis that the average life for each brand is the same.

Brand I	*Brand II*	*Brand III*
6	6	2
1	3	5
5	4	6
2	3	7

21. (i) Define the term validity
(ii) Explain various types of validity

ACTUARIAL SCIENCE: SYLLABI OF

COMPLEMENTARY COURSES FOR B.SC. STATISTICS PROGRAMME

CBCSSUG 2022 (2022 admission onwards)

Sem No	Course Code	Course Title	Instructional hours/week	Credit	Exam Hours	Ratio Ext.: Int.
1	BAS1C01	Financial mathematics	4	3	2	4:1
2	BAS2C02	Life contingencies	4	3	2	4:1
3	BAS3C03	Life contingencies and Principles of insurance	5	3	2	4:1
4	BAS4C04	Probability models and Risk theory	5	3	2	4:1

SEMESTER I
Course I
BAS1C01-FINANCIAL MATHEMATICS

Contact Hours per week: 4
Number of credits: 3
Number of Contact Hours: 72
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Describe how to use a generalized cash flow model in financial transaction.
CO 2: Apply different kinds of interest rates expressed in different time periods.
CO 3: Recall and use the more important compound interest functions, including annuities certain.
CO 4: Describe how a loan may be repaid by regular instalments of interest and capital.

Module I: Cash flow models, Cash flow process, Examples of cash flow scenarios, A zero-coupon bond, A fixed interest security, An index-linked security, Cash on deposit, An equity, An "interest-only" loan, A repayment loan (or mortgage), Insurance contracts, A pure endowment, An endowment assurance, A term assurance, A contingent annuity, A car insurance policy, A health cash plan.

10 Hours

Module II : The time value of money, Interest, Simple interest, Compound (effective) interest, Accumulation factors, The principle of consistency, Present values, Discount rates, Simple discount, Compound (effective) discount, Discount factors, Effective rates of interest and discount, Equivalent rates, Nominal rates of interest and discount, Accumulating and discounting using nominal interest rates, Accumulating and discounting using nominal discount rates, The force of interest, Accumulating and discounting using the force of interest, force of interest as a function of time, 1 Definition of real and money interest rates. Continuously payable cashflows (payment streams)

25 Hours

Module III: Level annuities, Present values, Payments made in arrear, Payments made in advance, Accumulations, Continuously payable annuities, Annuities payable pthly, Annuities payable pthly, Accumulations, Perpetuities, Perpetuities payable pthly, Deferred and increasing annuities, Deferred annuities, Continuously payable annuities, Continuously payable annuities, Varying annuities, Annual payments, Continuously payable annuities, Decreasing payments, Compound increasing annuities

20 Hours

Module IV: Equations of value, Solving for an unknown quantity, Solving for the timing of a payment (n), Solving for the interest rate (i), Loan schedules-Calculating the capital outstanding, Calculating the interest and capital elements, The loan schedule, Instalments payable more frequently than annually, Consumer credit: APR,

17 Hours

Books for study and reference:

1. Institute of Actuaries Act Ed. *Study materials* CM1
2. McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
3. Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
4. David Promislow, S. (2014), Fundamentals of Actuarial Mathematics, John wiley& sons.
5. Newton LBowers, et al (1997):Actuarial Mathematics, The Societies of Actuaries, 2nd Ed
6. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

SEMESTER II
Course II
BAS2C02-LIFE CONTINGENCIES

Contact Hours per week:4
Number of credits: 3
Number of Contact Hours: 72
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Recognize simple assurance and annuity contracts, and develop formulae for the means and variances of the present values of payments under these contracts.
CO 2: Know the concept of life table.
CO 3: Compute the probabilities of death and survival using life table.
CO 4: Perform calculations of the mean and variance of simple assurance and annuity contracts with standard actuarial functions, using specified life tables.

Module I: The life table, Introduction, Constructing a life table, The force of mortality, Lifetime random variables, The pattern of human mortality, Life table functions at non-integer ages, uniform distribution of deaths (UDD), constant force of mortality (CFM), Evaluating probabilities without use of the life table, Select mortality, Mortality rates that depend on both age and duration, Constructing select and ultimate life tables.

20 Hours

Module II: Life assurance contracts, Whole life assurance contracts, Term assurance contracts, Pure endowment contracts, Endowment assurance contracts, Deferred assurance benefits, Benefits payable immediately on death (Whole life assurance, Term assurance, Endowment assurance) Evaluating means and variances using select mortality, Other relationships.

17 Hours

Module III: Life annuity contracts, Whole life annuities payable annually in arrears, Whole life annuities payable annually in advance, Temporary annuities payable annually in arrears, Temporary annuities payable annually in advance, Deferred annuities, Deferred annuities-due, Continuous annuities, Other annuities.

17 Hours

Module IV: Evaluation of assurances and annuities, Evaluating assurance benefits, Evaluating annuity benefits, Premium conversion formulae, Expected present values of annuities payable m times each year, Expected present values under a constant force of mortality, Payments varying by a constant monetary amount (Whole life assurance, Term assurance, Endowment assurance, Decreasing term assurance), Whole life annuity payable annually in arrears, Whole life annuity payable annually in advance.

18 Hours

Books for study and reference:

1. Institute of Actuaries Act Ed. *Study materials* CM1
2. Dickson, D.C.M; Hardy M.R; Waters, H.R.-Actuarial Mathematics for life contingent risks: 2nd ed. Cambridge University Press (2013)
3. David Promislow, S. (2014), Fundamentals of Actuarial Mathematics, John wiley& sons.
4. Neill, Alistair, Heinemann, (1977): *Life contingencies.*
5. Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed
6. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

SEMESTER III
Course III
BAS3C03-LIFE CONTINGENCIES AND PRINCIPLES OF INSURANCE

Contact Hours per week: 5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Calculate gross premium of assurance and annuity contracts using gross future loss random variable.
CO 2: Describe and calculate reserve under assurance and annuity contracts using prospective and retrospective method of valuation.
CO 3: Demonstrate knowledge of life, general insurance contracts.
CO 4: Equip with the understanding of principles of insurance.
CO 5: Recall straightforward life table functions involving two lives and their respective probabilities.
CO 6: Compare between life and non-life insurance policies.

Module I: Gross premiums, Gross future loss random variable, Principle of equivalence, Determining gross premiums using the equivalence principle, Premiums payable m times per year, Annual premium contracts, Calculating gross premiums using simple criteria other than the equivalence principle.

20 Hours

Module II: Gross premium reserves, Why hold reserves, Prospective reserves, Calculating gross premium prospective reserves, Calculating prospective reserves that satisfy probabilities, Retrospective reserves, Retrospective accumulations, Gross premium retrospective reserve, Equality of prospective and retrospective reserves, Net premium reserves for conventional without profit contracts.

25 Hours

Module III: Joint life and last survivor functions, Random variables to describe joint life functions, Joint lifetime random variables and joint life table functions, Last survivor lifetime random variables, Simple probabilities involving two lives, Evaluating last survivor functions, Contingent probabilities of death.

25 Hours

Module IV: Principles of Insurance, The concept of Insurance, Concept of Risk-Peril-Hazard, Essential features of a contract, Insurance principles, Classification of Insurance business-Types of Life Insurance (Whole life, term, endowment, Money back policy, assurance for children, annuity plan, ULIP) ,Types of General insurance-fire ,marine, Miscellaneous (Motor, Liability, Pets, Aviation, Engineering, Agriculture, Health and Personal accident, Pecuniary loss, Fidelity guarantee, Business interruption cover, Travel, Home) Distribution between Life & General Insurance- Insurance Act, History of General Insurance in India.

20 Hours

Books for study and reference:

1. Institute of Actuaries Act Ed. *Study materials CM1*
2. Neill, Alistair, Heinemann, (1977): *Life contingencies.*
3. Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed
4. Jones, H.E & Long, D.L (2005): Principles of Insurance: Life, Health and annuities. LOMA
5. Dickson, D.C.M; Hardy M.R; Waters, H.R.-Actuarial Mathematics for life contingent risks: 2nd ed. Cambridge University Press (2013)
6. Neill, Alistair, Heinemann, (1977): *Life contingencies.*
7. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.

SEMESTER IV
Course IV
BAS4C04-PROBABILITY MODELS AND RISK THEORY

Contact Hours per week:5
Number of credits: 3
Number of Contact Hours: 90
Course Evaluation: External 60 Marks+ Internal 15 Marks
Duration of Exam: 2 Hours

Course Outcomes: *After successful completion of the course, students will be able to:*

CO 1: Explain the concept of survival models and apply its techniques.
CO 2: Describe the operation of simple forms of proportional and excess of loss reinsurance.
CO 3: Apply compound distributions in risk modelling.
CO 4: Memorize the basic concepts of ruin theory.

Module I: Survival models, Future lifetime, Probabilities of death and survival, The force of mortality, Survival probabilities, The probability density function of Tx, Life table functions, Initial and central rates of mortality, Expected future lifetime, Complete expectation of life, Curtate expectation of life, Some important formulae, Simple parametric survival models, The Gompertz and Makeham laws of mortality, Survival probabilities

25 Hours

Module II: Reinsurance, Proportional reinsurance, Non-proportional reinsurance, Reinsurance arrangements, Excess of loss reinsurance-The reinsurer's conditional claims distribution, Proportional reinsurance, Inflation.

20 Hours

Module III: Risk Models 1: General features of a product, Models for short-term insurance contracts, The collective risk model, The collective risk model, The basic model, Notation and assumptions, Distribution functions and convolutions, Moments of compound distributions, The compound Poisson distribution, The compound binomial distribution, The compound negative binomial distribution

25 Hours

Module IV: Risk Models 2: Aggregate claim distributions under proportional and individual excess of loss reinsurance, The individual risk model, Ruin theory, Basic concepts, The surplus process, The probability of ruin in continuous time, The probability of ruin in discrete time, Premium security loadings.

20 Hours

Books for study and reference:

1. Institute of Actuaries Act Ed. Study materials CS2.
2. Denuit,M., Marechal, X., Pitrebois, S., Walhin, J.F. (2007). Actuarial Modelling of claim counts: Risk classification, credibility and bonus-malus systems. John Wiley & Sons
3. Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed
4. Benjamin,B; Pollard, J.H. (1993).The analysis of mortality and other actuarial Statistics: (3rd Ed). Institute and faculty of Actuaries
5. Shailaja R. Deshmukh- Actuarial Statistics-an introduction using R, 3rd Ed.
6. Daykin C.D, Pentikainen T. , Pesonen M.: Practical Risk theory for Actuaries (1194). Chapman& Hall.

ACTUARIAL SCIENCE: MODEL QUESTION PAPERS OF COMPLEMENTARY COURSES FOR B.Sc. STATISTICS PROGRAMME

First Semester B.Sc. Statistics Degree Examination

Model Question Paper (2022 onwards)

Complementary Course for Statistics

BAS1C01-FINANCIAL MATHEMATICS

Time: Two Hours Maximum: 60 Marks

PART-A (Short Answer)

Each question carries ***two*** marks. Maximum **20** Marks

1. Define effective rate of interest.
2. Find the accumulated value, if principal of Rs.850 invested for 18 years at compound interest of 7.5% per annum.
3. Calculate $4/_{10}$ at 4.8% per annum convertible quarterly.
4. Calculate $^{(2)}_{12}$at 6% p.a. convertible monthly.
5. Calculate $_5$ at i=6%.
6. Calculate the present value of an annuity that pays Rs.2000 at times 0, 1, 2… using i=7.6% p.a. effective.
7. Calculate the flat rate of interest paid on a loan of Rs.48000 that is repaid over 25 years. Payments are made monthly. Each payment is 278
8. Define a Zero-Coupon bond.
9. Calculate $\bar{a}_{\overline{4}|}$ at 7.5% p.a.
10. Calculate P, if I=10, R=125, i=8% and n=10.
11. Define commercial rate of discount
12. What do you mean a fixed interest security?

Maximum Marks=20

PART-B (Paragraph)

Each question carries ***five*** marks. Maximum ***30*** marks

13. The force of interest is:

$$(t) = 0.01t + 0.04, 0 \leq t \leq 5.$$

Find the present value at time 0 of the payment stream$0.5 \quad + 2$, which is received between 0&5.

14. Derive the expression for the present value of an annuity immediate annuity.
15. A credit company offers a loan of Rs.5000. the loan is to be repaid over a 4 year term by level monthly installments of Rs.130 payable in arrears. What is the APR for the transaction?
16. A loan of Rs.250000 is being repaid by an annuity payable quarterly in arrear for 25 years. The annual amount of annuity is calculated at an effective rate of interest of 10% per annum.
    a) Calculate the quarterly payment under the annuity.
    b) Calculate the capital and interest in the 25^{th} payment.
17. Calculate the present value at time 0 of payments of Rs.50 at time 0, Rs.60 at time 1, Rs. 70 at time 2 and so on. The last payment is at time 10. Assuming that the annual effective rate of interest is 4.2%.

18. Find the present value of an immediate annuity of Rs.500 per annum payable quarterly for 12 years at the following rate of interest.
    a) 10% per annum
    b) 9% per annum convertible half yearly.
    c) 7.5% per annum convertible quarterly.
    d) 11% per annum convertible every two years.
19. Derive an expression for$(I\ddot{a})_{n|}$.

Maximum Marks=30

PART-C (Essay)

Each question carries ***ten*** marks. Maximum 10 marks

20. A loan of Rs.4000 is repayable over 5 years by level quarterly installments calculated using a rate of interest of 5% per annum effective.
    a) Calculate the amount of each quarterly installment.
    b) What is the capital content of the sixth repayment?
    c) How much interest is paid in the second year?
    d) Determine when the amount of loan outstanding falls below Rs.1000.
21. The force of interest is given by

$$(t) = \begin{cases} 0.04 + 0.002t, & 0 \le t < 10 \\ 0.015t - 0.08, & 10 \le t < 12 \\ 0.07 \quad , & t \ge 12 \end{cases}$$

    a) Find the expression for the accumulation factor from time 0 to t.
    b) Calculate the accumulation of Rs.150 from time t=0 to t=12

Maximum Marks=10

Second Semester B.Sc. Statistics Degree Examination

Model Question Paper (2022 onwards)

Complementary Course for Statistics

BAS2C02-LIFE CONTINGENCIES

Time: Two Hours Maximum: 60 Marks

PART-A (Short Answer)

Each question carries ***two*** marks. Maximum **20** Marks

1. Define curtate future life time.
2. Using ELT15 (Males) mortality, calculate the probability of a 37-year old dying between age 65 and age 75.
3. Define select mortality.
4. Define temporary annuity contract.
5. Prove the identity $\delta\bar{a}_x + \bar{A}_x = 1$.
6. Calculate ${}_4P_{30}$ and ${}_2\,{}_{40}$ from AM92 ultimate mortality at 4% interest.
7. Define whole life insurance contract.
8. Claire, aged exactly 30, buys a whole life assurance with a sum assured of £50,000 payable at the end of the year of her death. Calculate the standard deviation of the present value of this benefit using AM92 Ultimate mortality and 6% pa interest.
9. Derive the variance expression of whole life annuity due.
10. A level annuity of £1,000 pa is to be paid continuously to a 40-year-old male for the rest of his life. On the basis of 4% pa interest and AM92 Ultimate mortality, calculate the expected present value of this annuity.
11. Find a_{65} (PFA92C20 at 4%).
12. Prove that $A_x + d\ddot{a}_x = 1$

Maximum Marks=20

PART-B

Each question carries ***five*** marks. Maximum ***30*** marks

13. Explain whole life annuities payable annually in arrears.
14. Explain the procedure of constructing a life table.
15. Briefly explain about deferred annuity.
16. Explain continuous Whole life Assurance contract. Find its mean and variance.
17. Explain n-year temporary life annuity.
18. Calculate the values of:
    (i) ${}^{1}_{40:25}$
    (ii) ${}_{30:25}$
    (iii) $\bar{A}_{30:25}$
    using AM92 mortality and 4% pa interest.
19. A population is subject to a constant force of mortality of 0.015 pa. Calculate:
    (i) The probability that a life aged exactly 20 dies before age 21.25.
    (ii) The probability that a life aged exactly 22.5 dies between the ages of 25 and 27
    (iii) The complete expectation of life for a life aged exactly 28.

Maximum Marks=30

PART-C (Essay)

Each question carries ***ten*** marks. Maximum 10 marks

20. Explain the following:
    i. Temporary annuities payable annually in advance.
    ii. Endowment assurance contract.
21. Calculate ${}_3P_{62.5}$ based on the PFA92C20 table in the table using
    i. The UDD assumption.
    ii. The CFM assumption.

Maximum Marks=10

Third Semester B.Sc. Statistics Degree Examination

Model Question Paper (2022 onwards)

Complementary Course for Statistics

BAS3C03-LIFE CONTINGENCIES AND PRINCIPLES OF INSURANCE

Time: Two Hours Maximum: 60 Marks

PART-A (Short Answer)

Each question carries ***two*** marks. Maximum **20** Marks

1. Define pecuniary loss.
2. Define Principle of equivalence
3. Define Prospective reserve.
4. What are the conditions for Equality of prospective and retrospective reserves
5. What is valuation of the policy?
6. Define Hull insurance.
7. Define net premium.
8. Define gross future loss random variable.
9. What does ${}_tP_{xy}$ mean?
10. Define joint life status.
11. Define ${}_n{}^1$
12. Define reserve.

Maximum Marks=20

PART-B (Paragraph)

Each question carries ***five*** marks. Maximum ***30*** marks

13. Distinguish between Life Insurance and General Insurance.
14. Briefly explain Fire Insurance and Marine Insurance.
15. Explain benefit reserve under fully continuous Whole life Insurance.
16. Calculate the annual premium for a term assurance with a term of 10 years to a male aged 30, with a sum assured of Rs.500000, assuming AM92 ultimate mortality and interest of 4% p.a. Assume that the death benefit is payable at the end of the year of death.
17. A 10-year term assurance with a sum assured of £500,000 payable at the end of the year of death, is issued to a male aged 30 for a level annual premium of £330.05. Calculate the prospective reserve at the end of the fifth year, *ie* just before the sixth premium has been paid, assuming AM92 Ultimate mortality and 4% *pa* interest.
18. Explain fully continuous whole life premium.
19. Calculate the following using AM92 ultimate mortality
    i. ${}_3P_{45:41}$
    ii. ${}_{66:65}$
    iii. $\mu_{38:30}$.

Maximum Marks=30

PART-C (Essay)

Each question carries ***ten*** marks. Maximum 10 marks

20. Explain the present values of joint life and last survivor assurances.

21. A 25-year endowment assurance policy provides a payment of £75,000 on maturity or at the end of the year of earlier death. Calculate the annual premium payable for a policyholder who effects this insurance at exact age 45. Expenses are 75% of the first premium and 5% of each subsequent premium, plus an initial expense of £250.
    Assume AM92 Select mortality and 4% pa interest.

Maximum Marks=10

Fourth Semester B.Sc. Statistics Degree Examination

Model Question Paper (2022 onwards)

Complementary Course for Statistics

BAS4C04-Probability Models and Risk Theory

Time: Two Hours Maximum: 60 Marks

PART-A (Short Answer)

Each question carries ***two*** marks. Maximum **20** Marks

1. Define survival function.
2. Define force of mortality
3. Suppose X~ exp(μ) and $N \sim Geo(p)$. Find $M(t)$.
4. Define compound Poisson distribution.
5. Obtain the mean and variance of the claim random variable X, where q=0.06 and the claim amount is fixed at B.
6. What is time of ruin?
7. Define premium security loading.
8. Define reinsurance policy.
9. Define Gompertz law of mortality.
10. What do you mean by insurable interest.
11. Define central rate of mortality.
12. Explain what $S_{29}(36)$ represents.

Maximum Marks=20

PART-B

Each question carries ***five*** marks. Maximum ***30*** marks

13. Distinguish between complete expectation of life and curtate expectation of life.
14. Explain Proportional Reinsurance arrangement.
15. The distribution of the number of claims from a motor portfolio is negative binomial with parameter k=4000 and p=0.9. The claim size distribution is Pareto with parameter α =5 and λ= 1200. Calculate the mean variance of aggregate claim distribution.
16. Does the compound binomial distribution have an additive property? If so, state the property carefully.
17. A compound distribution S is such that P(N=0)=0.6, P(N=1) =0.3 and P(N=2)=0.1. Claim amounts are either 1 unit or 2 units, each with probability 0.5. Derive the distribution function of S.
18. Claims from a particular portfolio have a generalised Pareto distribution with parameters α= 6 , λ=200 and k = 4 . A proportional reinsurance arrangement is in force with a retained proportion of 80%. Calculate the mean and variance of the amount paid by the insurer and the reinsurer in respect of a single claim.
19. Suppose that N ~ Poisson(λ) , M ~ Poisson(μ) , and N and M are independent. Use a convolution approach to derive the probability function of N+M.

Maximum Marks=30

PART-C (Essay)

Each question carries ***ten*** marks. Maximum 10 marks

20. a) Show that sums of independent compound Poisson random variables is itself aCompound Poisson random variable.

    b) If N has a Poisson distribution with mean λ, show that $M(t) = \exp(\lambda\ (M_{\mathrm{K}}(t) - 1))$.

21. a) Explain the surplus process.

    b) Explain probability of ruin in continuous time

Maximum Marks=10

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