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UNIVERSITY OF CALICUT

Abstract

BSc Programme in Statistics -CUCBCSS UG 2014-Scheme and Syllabus-Implemented w.e.f 2014 Admissions-Corrigendum issued.

G & A - IV - J

U.O.No. 3990/2016/Admn Dated, Calicut University.P.O, 05.04.2016

Read:-U.O.No. 6916/2014/Admn Dated, Calicut University.P.O, 17.07.2014

ORDER

The following Corrigenda are issued to the University Order read above.

CORRIGENDUM

(a) The Pattern of distribution of Marks/ Credits restructured.

(b) The Model Questionpapers for semester III and semester IV for both core and complementary courses in Statistics added to the syllabus.

The U.O. read above stands modified to this extent.

(The corrected syllabus is attached to this U.O)

Anuja Balakrishnan
Deputy Registrar

To

1. All Affiliated Colleges/SDE/Dept.s/Institutions under University of Calicut.
2. The Controller of Examinations, University of Calicut.
3. The Director SDE, University of Calicut

Forwarded / By Order

Section Officer

APPROVED SYLLABUS

SYLLABUS FOR B.Sc. STATISTICS-SEMESTER SYSTEM (APPROVED)- CCSS 2014 (2014 ONWARDS)

1. CORE COURSES
2. ELECTIVE COURSES
3. OPEN COURSES
4. COMPLEMENTARY COURSES

Credit Distribution for Core and Complementary Statistics

Semester	Core Course	Complementary Course		Open Course	Project	Elective	Total
		Mathematics	Optional				
I	4	3	3				10
II	4	3	3				10
III	4	3	3				10
IV	4	3	3				10
V	18			2			20
VI	18				2	2	22
	52	**12**	**12**	**2**	**2**	**2**	**82**

Credit Distribution for languages

Semester	Common Course	
	English	Additional Language
I	4+3	4
II	4+3	4
III	4	4
IV	4	4
V	-	
VI	-	
	22	**16**

Total credits are 120.

Mark Distribution

Sl.No	Course	Marks
1	English	600
2	Additional Language	400
3	Core Course Statistics	1550
4	Complementary Course I-Mathematics	400
5	Complementary Course II-Optional	400
6	Open Course	50
		3400

QUESTION PAPER PATTERN FOR CORE AND COMPLEMENTARY

For a paper, total marks is 80+20=100.
External: 80marks
Internal: 20 mark
Open course, 40+10=50
Project work, 40+10=50

Distribution of Marks and Type questions (Core and Complementary).

Category	total Questions	To be answered	Marks for each question	Total
Section A – one word	10	10	1	10
Section B- One sentence	7	7	2	14
Section C- Paragraph	5	3	4	12
Section D- Short essay	6	4	6	24
Section E- Essay	4	2	10	20
			Total	80

*the pattern of questions and mark distribution for theory papers named 'practicals' for core course in semester V and IV is different from this.

Distribution of Marks and Credits for practical papers (Core)

Each practical paper has a credit of 2. The question paper includes 6 questions of 20 marks each. The student has to answer 4 questions and the maximum marks for each paper is 80.

Internal marks distribution for CORE AND COMPLEMENTARY including practical papers of Core

1	attendance	**8**
2	assignments	4
3	Test papers-2-	8
	Total	20

Distribution of Marks and Type questions (Open course)

Category	total Questions	To be answered	Marks for each question	Total
Section A –one word	5	5	1	5
Section B- One sentence	5	5	2	10
Section C- Paragraph	5	3	5	15
Section D-Essay	3	1	10	10
			Total	40

Internal marks distribution for OPEN courses

1	attendance	**4**
2	assignments	2
3	Test papers-2-	4
	Total	10

Project Evaluation- External

1	Work book	8
2	Topic, methodology	10
3	Presentation	12
4	viva	10
	Total	**40**

Project Evaluation- Internal

1	Preparation, Methodology	2
2	Data Analysis	2
3	Report submission	2

4	Viva	4
	Total	**10**

Paper Details- Core

Semester	Course Code	Course Title	Credit
I	ST1B01	BASIC STATISTICS AND PROBABILITY	4
II	ST2B02	BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS	4
III	ST3B03	STATISTICAL ESTIMATION	4
IV	ST4B04	TESTING OF HYPOTHESIS	4
V	ST5B05	MATHEMATICAL METHODS IN STATISTICS	4
	ST5B06	STATISTICAL COMPUTING	4
	ST5B07	SAMPLE SURVEYS	4
	ST5B08	OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL	4
	ST5B09	PRACTICAL PAPER-1	2
		OPEN COURSE OFFERED BY OTHER FACULTIES	2
VI	ST6B10	TIME SERIES AND INDEX NUMBERS	4
	ST6B11	DESIGN OF EXPERIMENTS	4
	ST6B12	POPULATION STUDIES AND ACTUARIAL SCIENCE	4
	ST6B13	LINEAR REGRESSION ANALYSIS	4
	ST6B14	PRACTICAL	2
V & VI	ST6B15	PROJECT WORK	2
VI	ST6B16	ELECTIVE PAPER	2

OPEN COURSES

Semester	Course	Course Title	Credit
V	ST5D01	ECONOMIC STATISTICS	2
	ST5D02	QUALITY CONTROL	2
	ST5D03	BASIC STATISTICS	2

ELECTIVE COURSES

Semester	Course	Course Title	Credit
VI	ST6B16(E01)	ACTUARIAL SCIENCE-PROBABILITY MODELS AND	2

		RISK THEORY	
	ST6B16(E02)	STOCHASTIC MODELLING	2
	ST6B16(E03)	RELIABILITY THEORY	2

COURSE DETAILS

1. CORE COURSES

Semester	Course	Course Title	Instructional Hours per week	Credit	Exam Hours	Ratio Ext: Int
1	1	BASIC STATISTICS AND PROBABILITY	4	4	3	4:1
2	2	BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS	4	4	3	4:1
3	3	STATISTICAL ESTIMATION	5	4	3	4:1
4	4	TESTING OF HYPOTHESIS	5	4	3	4:1
5	5	MATHEMATICAL METHODS IN STATISTICS	5	4	3	4:1
5	6	STATISTICAL COMPUTING	5	4	3	4:1
5	7	SAMPLE SURVEYS	5	4	3	4:1
5	8	OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL	5	4	3	4:1
5	9	PRACTICAL PAPER-1	-	2	3	4:1
5		OPEN COURSE OFFERED BY OTHER FACULTIES	3	2	3	4:1
6	10	TIME SERIES AND INDEX NUMBERS	5	4	3	4:1
6	11	DESIGN OF EXPERIMENTS	5	4	3	4:1
6	12	POPULATION STUDIES AND ACTUARIAL SCIENCE	5	4	3	4:1
6	13	LINEAR REGRESSION ANALYSIS	5	4	3	4:1
6	14	PRACTICAL	-	2	3	4:1
5-6	15	PROJECT WORK	4	2		4:1

6	16	ELECTIVE PAPER	3	2	3	4:1

2. ELECTIVE COURSES

Semester	Course	Course Title	Instructional Hours per week	Credit	Exam Hours	Ratio Ext: Int
6	1	ACTUARIAL SCIENCE-PROBABILITY MODELS AND RISK THEORY	3	2	3	4:1
6	2	STOCHASTIC MODELLING	3	2	3	4:1
6	3	RELIABILITY THEORY	3	2	3	4:1

3. OPEN COURSES

Semester	Course	Course Title	Instructional Hours per week	Credit	Exam Hours	Ratio Ext: Int
5	1	ECONOMIC STATISTICS	3	2	3	4:1
5	2	QUALITY CONTROL	3	2	3	4:1
5	3	BASIC STATISTICS	3	2	3	4:1

CORE COURSE I: BASIC STATISTICS AND PROBABILITY

Module 1: Measures of central tendency-arithmetic mean, weighted arithmetic mean, geometric mean, harmonic mean, median, mode, partition values-quartile, percentile, measures of deviations-variance, standard deviation, mean deviation about mean, quartile deviation, co-efficient of variation.
15 hours
Module 2: Random experiment, 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.
25 hours
Module 3: Random variable-discrete and continuous, probability mass function (pmf) and probability density function (pdf)-properties and examples, cumulative Distribution function and its properties, change of variable (univariate case).
15 hours
Module 4: 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 Correlation, Multiple Correlation, regression, two regression lines, regression coefficients.
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 (6^{th} edn), Pearson Edn, NewDelhi

CORE COURSE 2. BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS

Module 1: Bivariate random variable, joint pmf and joint pdf, marginal and conditional probability, independence of random variables, 15 hours
Module 2: Mathematical expectations-definition, raw and central moments (definition and relationships), moment generating function and properties, characteristic function (definition and use only), covariance and correlation.
20 hours
Module 3: Skewness and kurtosis using moments, Bivariate case-conditional mean and variance, covariance, Karl Pearson Correlation coefficient, independence of random variables based on expectation.
12 hours
Module 4: Standard distributions-Discrete type-Bernoulli, Binomial, Poisson, Geometric, negative binomial (definition, properties and applications), Uniform (mean, variance and mgf), Continuous type-Uniform, exponential, gamma, Beta,

Normal (definition, properties and applications), Lognormal, Pareto and Cauchy (Definition only)
25 h

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 (6^{th} edn), Pearson Edn, NewDelhi

CORE COURSE 3. STATISTICAL ESTIMATION

Module 1: Limit Theorems: Chebyshev's inequality, Convergence in probability (definition and example only), weak law of large numbers (iid case), Bernoulli law of large numbers.Central limit theorem (Llindberg. Levy-iid case)
15 hours

Module 2: 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, property and relationships only).
20 hours

Module 3: 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. 25 hours

Module 4: Methods of Estimation; method of maximum likelihood, method of moments, method of least squares, Concept of Bayesian estimation 15 hours.

Module 5; 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;
15 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

CORE COURSE 4. TESTING OF HYPOTHESIS

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 ;
20 hours

Module 2: Large sample tests concerning mean, equality of means, proportions, equality of proportions. Small sample tests based on t distribution for mean, equality of means and paired t test:
30 hours
Module 3: Tests based on F distribution. Teats based on chi square distribution for variance, goodness of fit and for independence of attributes .Test for correlation coefficients.:
20 hours.
Module 4: Non parametric tests. advantages, disadvantages ,Kolmogrov Smirnov test, one sample and two sample sign tests. Wilcoxon signed rank test, Median test, Mann Whitney test, Krukal Wllis and test for randomness (run test): 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

CORE COURSE 5. MATHEMATICAL METHODS IN STATISTICS

Module 1: Real Number system: Mathematical induction, order properties of real number, Bernoulli, Cauchy, triangle inequality, absolute value, Completeness property-suprema & infima, Archimedian property, Density theorem, nested interval property.
20 hours
Module 2: Sequences: Limit, limit theorems, Squeeze theorem, convergence of sequence, root test and ratio test, monotone convergence theorem, subsequence and Bolzano-Weierstrass theorem, Cauchy criterion, limits of functions, limit theorems of functions,
25 hours
Module 3: 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
Books of references

1. Malik S.C. and Savitha Arora, Real Analysis, New Age International
2. Robert G Bartle, Real Analysis, Wiely
3. Shanti Narayanan, Elements of Real Analysis

CORE COURSE 6. STATISTICAL COMPUTING

Module 1: 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.
15 Hours
Module 2: Descriptive statistics:, diagrammatic representation of univariate and bivariate data (box plots, stem and leaf diagrams, bar plots, pie diagram, scatter plots), 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.
25 Hours

Module 3: Probability Distributions: R as a set of statistical tables- cumulative distribution, probability density function, quantile function, and simulate from the distribution, plotting probability curves for standard distributions.
15 Hours
Module 4: Statistical Inference: classical tests: 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 and two-way), correlation and regression analysis(bivariate and multivariate data), polynomial regression
25 Hours

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)

CORE COURSE 7. SAMPLE SURVEYS

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
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 random sampling.
20 hours
Module 4: Systematic Sampling: Linear and circular systematic sampling, comparison with simple random sampling.
10 hours

Module 5: 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.
20 hours

Books for 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 Estrn Limitted
3. Cochran W.G, Sampling Techniques, Wiely Estern

CORE COURSE 8. OPERATIONS RESEARCH AND STATISTICAL QUALITY CONTROL

Module 1: Linear programming: Mathematical formulation of LPP, Graphical and Simplex methods of solving LPP-duality in linear programming
20 hours
Module 2: Transportation and assignment problems, North-west corner rules, row column and least cost method-Vogel's approximation method, Assignment problem, Hungarian algorithm of solution
20 hours
Module 3: 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
25 hours
Module 4: Principles of acceptance sampling-problems and 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
25 hours

Books for references

1. Gupta and Manmohan, Linear programming, 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

CORE COURSE 9 PRACTICAL 1.

Topics for practical 1

Numerical questions from the following topics of the syllabi are to be asked for external examination of this paper. The questions are to be evenly chosen from these topics.

. The students have to maintain a practical record. The numerical examples of the following topics are to be done by the students of the fifth semester class under the supervision of the teachers and to be recorded in the record book. The valuation of the record shall be done internally

1. Small sample test
2. Large sample test
3. Construction of confidence intervals
4. Sample surveys

CORE COURSE 10. TIME SERIES AND 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**. 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 attitude-Guttman scale-Semantic differential scale-Likert scale-selection of appropriate scale-limitations of scales- **15** hours

Books for 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

CORE COURSE 11. DESIGNS OF EXPERIMENTS

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

25 hours

Module 2: Analysis of variance, one way and two way classification (with single observation per cell), Analysis of covariance with a single observation per cell.

25 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.

25 hours

Module 4: Basic concepts of factorial experiments, 2^3 factorial experiments, Duncan's multiple range test.

15 hours

Books for references

1. S.C. Gupta and V K Kapoor, Fundamentals of applied Statistics, Sulthan Chand and Sons
2. Federer, Experimental Designs
3. M N Das and N Giri, Design of Experiments, New Age international,
4. DD Joshy, linear Estimation and Design of Experiments, Wiley Eastern
5. Montgomeri, Design of Experiments

CORE COURSE 12 POPULATION STUDIES AND ACTUARIAL SCIENCE

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.
20 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
40 hours
Module 3: Fundamentals of insurance: Insurance defined meaning of loss, peril, hazard and proximate cause in insurance, Costs and benefits of insurance to society-branches of insurance. Insurable loss exposures-feature of loss that is deal of insurance, Construction of Mortality table-computation of premium of life insurance for fixed duration and for the whole life.
30 hours
Books for reference

1. S.C. Gupta and V K Kapoor, Fundamentals of applied Statistics, Sulthan Chand and Sons
2. Benjamin B, Health and Vital Statistics, Allen and Unwin
3. Mark S Dorfman, Introduction to Risk Management and Insurance, Prentice Hall
4. C.D.Daykin, T. Pentikainen et al, Practical Risk Theory of Acturies, Chapman and Hill

CORE COURSE 13. REGRESSION ANALYSIS

Module 1: Least Square estimation: Gauss-Markoff Setup, Normal equations and least square Method of estimation, properties of estimator, variance of estimator, Estimation of variance.
25 hours
Module 2: Linear Regression: Simple linear regression model, least square estimation of parameters, Hypothesis testing of slope and intercept, co-efficient of determination.
20 hours

Module 3: Multiple Regressions: Model, estimation of model parameters, test for significance of regression, regression co-efficient, co-efficient of determination, use of ANOVA
25 hours
Module 4: Polynomial and logistic regression: Models and method of estimation, logistic regression-binary-model and estimates
20hours

References

1. D C. Montegomerry, E A Peak and G G Vining, Introduction to Linear regression analysis, Wiley 2003

CORE COURSE 14. PRACTICAL 2

Topics for practical 2

Numerical questions from the following topics of the syllabi are to be asked for external examination of this paper. The questions are to be evenly chosen from these topics.

. The students have to maintain a practical record. The numerical examples of the following topics are to be done by the students of the sixth semester class under the supervision of the teachers and to be recorded in the record book. The valuation of the record shall be done internally

1. Design of Experiments
2. Construction of Control charts
3. Linear programming
4. Time series
5. Index numbers

Paper 15
PROJECT

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.

Paper 16
ELECTIVE COURSES

ELECTIVE COURSE 1. PROBABILITY MODELS AND RISK THEORY

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 re-insurance on the probability of ruin
14 hours
Books for reference

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

ELECTIVE COURSE 2. STOCHASTIC MODELLING

Module 1: Concept of mathematical modeling, definition, natural testing a informal mathematical representations. **10 hours**

Module 2: Concept of stochastic process, probability generating functions, convolution generating function of sum of independent random variables, Definition of a stochastic process, classification, Markov chain, transition probabilities, Chapmann and Kolmogrov equations, transition probability matrices, examples and computation.

30 hours

Module 3: First passage probabilities, classification of states, recurrent, transient and ergodic states, stationary distribution, mean ergodic.

14 hours

Books for reference

1. V K Rohatgi, An introduction to probability theory and mathematical statistics, Wiley eastern
2. S M Ross, An Introduction to Probability Theory and Stochastic Models
3. V K Rohadgi Statistical Inference, Wiley Eastern

ELECTIVE COURSE 3. RELIABILITY THEORY

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

Books for 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

OPEN COURSE 1. ECONOMIC STATISTICS

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

Books for references

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

OPEN COURSE 2. QUALITY CONTROL

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 and sons
3. Montegomery D C, Introduction to Statistical Quality Control, John Wiley and sons

OPEN COURSE 3. BASIC STATISTICS

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.
15 hours

Module 2: Measures of Central tendency: Mean, median and mode and their empirical relationships, weighted arithmetic mean-Dispersion: absolute and relative measures, standard deviation and coefficient of variation.
15 hours

Module 3: Fundamental characteristics of bivariate data: univariate and bivariate data, scatter diagram, curve fitting, principle of least squares, fitting of straight line. Simple correlation, Pearson's correlation coefficient, limit of correlation coefficient, invariance of correlation coefficient under linear transformation.
19 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).
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

COMPLEMENTARY COURSE

COMPLEMENTARY PAPERS IN STATISTICS

Semester	Course Code	Course Title	Instructional Hours per week	Credit	Exam Hours	Ratio Ext: Int
1	ST1CO1	BASIC STATISTICS AND PROBABILITY	4	3	3	4:1
2	ST2CO2	PROBABILITY DISTRIBUTIONS	4	3	3	4:1
3	ST3CO3	STATISTICAL INFERENCE	5	3	3	4:1
4	ST4CO4	APPLIED STATISTICS	5	3	3	4:1

COMPLEMENTARY COURSE I: BASIC STATISTICS AND PROBABILITY

Module 1: Population, sample, , measures of central tendency-arithmetic mean, weighted arithmetic mean, geometric mean, harmonic mean, median, mode, partition values-quartile, percentile, measures of deviations-variance, standard deviation, mean deviation about mean, quartile deviation, co-efficient of variation,

20 hours

Module 2: Fitting of straight line, parabola, exponential, polynomial, (least square method), correlation, regression, two regression lines, regression coefficients,properties- .rank correlation, partial and multiple correlation (3 variables)

15 hours

Module 3: Random experiment, Sample space, event, classical definition of probability, statistical regularity, relative frequency definition, field, sigma field, axiomatic definition of probability and simple properties, concept of probability measure, addition theorem (two and three events), conditional probability of two events, multiplication theorem, independence of events(pair wise and mutual), Bayes theorem. –numerical problems

25 hour

Module 4: Random variable-discrete and continuous, probability mass function (pmf) and probability density function (pdf)-properties and examples, cumulative Distribution function and its properties, change of variable (univariate case)

12 hours

References

5. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
6. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chan and Sons
7. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
8. John E Freund, Mathematical Statistics (6^{th} edn), Pearson Edn, NewDelhi

COMPLEMENTARY COURSE II- PROBABILITY DISTRIBUTIONS

Module 1: Mathematical expectations (univariate): Definition, raw and central moments (definition and relationships), moment generating function and properties, characteristic function (definition and use only), Skewness and kurtosis (using moments)

15 hours

Module 2: Bivariate random variable: joint pmf and joint pdf, marginal and conditional probability, independence of random variables, function of random variable. Bivariate Expectations, conditional mean and variance, covariance, Karl Pearson Correlation coefficient, independence of random variables based on expectation.

15 hours

Module 3: Standard distributions: Discrete type-Bernoulli, Binomial, Poisson, Geometric, negative binomial (definition, properties and applications), Uniform (mean, variance and mgf), Continuous type-Uniform, exponential, gamma, Beta, Normal (definition, properties and applications), Lognormal, Pareto and Cauchy (Definition only)

30 hours

Module 4:: Chebyshev's inequality, variables, Convergence in probability weak law of large numbers (iid case), Bernoulli law of large numbers, example only), Central limit theorem (Lindberg Levy-iid case)

12 hours

References

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

COMPLEMENTARY COURSE III. STATISTICAL INFERENCE

Module 1: Sampling distributions: Statistic, Sampling distribution of a 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

Module 2: Theory of Estimation: Point Estimation, desirable properties of a good estimator, unbiasedness, consistency, sufficiency, Fisher Neyman factorization theorem, efficiency.Methods of Estimation:- Method of maximum likelihood, method of moments.

20 hours

Module 3: Interval Estimation: Interval estimates of mean, difference of means, variance, proportions and difference of proportions. Derivation of exact confidence

intervals for means, variance and ratio of variances based on normal, t, chi square and F distributions:
15 hours
Module 4: Testing of Hypotheses: concept of testing hypotheses, simple and composite hypotheses, null and alternative hypotheses, type I and II errors, critical region, level of significance and power of a test. Neyman Pearson approach: Large sample tests concerning mean equality of means, proportions, equality of proportions, Small sample tests based on t distribution for mean, equality of means and paired t test. Tests based on Fdistribution for ratio of variances. Tests based on Chi square distribution for variance, goodness of fit and for independence of attributes:
30 hours

References

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

COMPLEMENTARY COURSE IV: APPLIED STATISTICS

Module 1:Census and Sampling, Principal steps in a sample survey, different types of sampling, Organisation and execution of large scale sample surveys, errors in sampling (Sampling and nonsampling errors) preparation of questionnaire, simple random sampling with and without replacement, Systematic,stratified and cluster sampling (concept only)
20 hours
Module 2:Analysis of variance; one way, two way classifications. Null hypothesis, total, between and within sum of squares. Assumptions-ANOVA table..
15 hours
Module 3: Time series :Components of time series-additive and multiplicative models, measurement of trend, moving averages, seasonal indices-simple average-ratio to moving average.
Index numbers: meaning and definition-uses and types- problems in the construction of index numbers- different types of simple and weighted index numbers. Test for an ideal index number- time and factor reversal test.
30 hours

Module 4:Statistical Quality Control: Concept of statistical quality control, assignable causes and chance causes, process control. Construction of control charts, 3sigma limits. Control chart for variables-Mean chart and Range chart. Control chart for attributes- pchart, d or np chart and chart
25 hours

References

1. S.C.Gupta and V. K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand and Sons
2. Grant E L, Statistical quality control, McGraw Hill
3. Duncan A J, Quality Control and Industrial Statistics, Taraporewala and sons
4. Montegomery D C, Introduction to Statistical Quality Control, John Wiley and sons
5. S.P.Gupta: statistical methods

SYLLABUS OF COMPLEMENTARY II- ACTUARIAL SCIENCE
STATISTICS: COMPLEMENTARY – II
CUCCSSUG 2014 (2014 admission onwards)

Sem No	Course code	Course Title	Instructional Hours/week	Credit	Exam Hours	Ratio Ext: Int
1	AS1C01	**FINANCIAL MATHEMATICS FINANCIAL MATHEMATICS**	4	3	3	4:1
2	AS2C02	**FINANCIAL MATHEMATICS**	4	3	3	4:1
3	AS3C03	**LIFE CONTINGENCIES AND PRINCIPLES OF INSURANCE**	5	3	3	4:1
4	AS4C04	**LIFE CONTINGENCIES AND PRINCIPLES OF INSURANCE**	5	3	3	4:1

SEMESTER I
Course I
Financial mathematics

Module I: Rates of interest-Simple and Compound interest rates-Effective rate of interest Accumulation and Present value of a single payment-Nominal rate of interest-Constant force of interest-Relationship between these rate of interest-Accumulation and Present value of a single payment using these rate of interest-Accumulation and Present value of a single payment using these symbols-When the force of interest is a function of t, $\delta(t)$.Definition of A(t1,t2),A(t),v(t1,t2) and v(t).Expressing accumulation and present values of a single payment using these symbols-when the force of interest is a function of t, $\delta(t)$ **22hrs**

Module II: Series of payments-Definition of annuity (Ex:-real life situation)-Accumulation and present vales of annuities with level payments and where the payments and interest rates have same frequencies- Definition and derivation –Definition of perpetuity and derivation- Accumulation and present values of annuities where payments and interest rates have different frequencies **22hrs**

Module III: Increasing and decreasing annuities-Definition and derivation—Annuities payable continuously-Annuities where payments are increasing continuously and payable continuously-Definition and derivation **10hrs**

Module IV: Loan schedules-Purchase price of annuities net of tax-consumer credit transaction **18hrs**

Books for study and reference:

Institute of Actuaries Act Ed. *Study materials*
McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
Neill, Alistair, Heinemann, (1977): *Life contingencies.*
Bowers, Newton Let al Actuaries, 2nd Ed

SEMESTER II

Course II Life contingencies

Module I: Survival distribution and Life tables:
Probability for the age at death- life tables- The deterministic survivorship group. Other life table functions, assumptions for Fractional Ages Some analytical laws of mortality select and ultimate life table **25hrs**

Module II: Multiple life functions: Joint life status-the last survivor status-Probabilities and expectations-Insurance and annuity benefits- Evaluation-Special mortality laws-Evaluation-Uniform distribution of death-Simple contingent functions-Evaluation **10hrs**

Module III: Evaluation of assurance:
Life assurance contracts-(whole, n-year term, n-year endowment, deferred) Insurance payable at the moment of death and insurance payable at the end of year of death-Recursion equations- Commutation functions **19hrs**

Module IV: Life annuities: single payment contingent on survival-Continuous life annuities-Discrete life annuities-Life annuities with monthly payment Commutation Function formulae for annuities with level payments-Varying annuities-Recursion equations-complete annuities-immediate and apportion able annuity –due
18hrs

Books for study and reference:
Institute of Actuaries Act Ed. *Study materials*
McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
Neill, Alistair, Heinemann, (1977): *Life contingencies.*
Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed

SEMESTER III
Course III
Life contingencies and Principles of insurance

Module I: Net premiums: Fully continuous premiums-fully discrete premiums-True mthly payment premiums-Apportion able premiums-Commutation functions-Accumulation type benefits **20hrs**

Module II: Fully continuous net premium reserves-other formulas for fully discrete net premium results-Reserves on semi continuous basis- Reserves based on semi continuous basis-Reserves based on apportion able or discounted continuous basis-Recursive formulae for fully discrete basis-Reserves at fractional duration-Allocation of the loss to the policy years-Differential equation for fully continuous reserves **25hrs**

Module III: Concept of Risk-the concept of Insurance-Classification of Insurance-Types of Life Insurance-Insurance Act, fire ,marine, motor engineering, Aviation and agricultural-Alternative classification-Insurance of property-pecuniary interest, liability &person, Distribution between Life & General Insurance-History of General Insurance in India. **25hrs**

Module IV: The Economic of Insurance: Utility theory-Insurance and Utility melements of Insurance-optimal insurance-Multiple decrement models
20 hrs

Books for study and reference:
Institute of Actuaries Act Ed. *Study materials*
McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
Neill, Alistair, Heinemann, (1977): *Life contingencies.*
Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed

SEMESTER IV

Course IV

Probability models and Risk theory

Module I: Individual risk model for a short time: Model for individual claim random variables-Sums of independent random variable- Approximation for the distribution of the sum-Application to insurance **20hrs**

Module II: Collective risk models for a single period: The distribution of aggregate claims-Selection of basic distributions-Properties of compound Poisson distributions –Approximations to the distribution of aggregate claims **25hrs**

Module III: Collective risk models over an extended period: Claims process-
The adjustment coefficient-Discrete time model-The first surplus below the initial level-The maximal aggregate loss **20hr**s

Module IV: Application of risk theory: Claim amount distributions-Approximating the individual model-Stop-loss re-insurance-The effect of re-insurance on the probability of ruin **25hrs**

Books for study and reference:

Institute of Actuaries Act Ed. *Study materials*
McCutcheon, J.J., Scott William (1986): An introduction to Mathematics of Finance
Butcher,M.V., Nesbit, Cecil. (1971)Mathematics of compound interest, Ulrich's Books
Neill, Alistair, Heinemann, (1977): *Life contingencies.*
Bowers, Newton Let al (1997): Actuarial mathematics, society of Actuaries, 2nd Ed

STATISTICS: COMPLEMENTARY – I Syllabus for BSc.

CUCCSSUG 2014 (2014 admission onwards)

SYLLABUS FOR BSc. (GEOGRAPHY MAIN)

Sem No	Course code	Course Title	Instructional Hours/week	Credit	Exam Hours	Ratio Ext: Int
1	SG1C01	**STATISTICAL METHODS**	4	3	3	4:1
2	SG2C02	**REGRESSION ANALYSIS, TIME SERIES AND INDEX NUMBERS**	4	3	3	4:1
3	SG3C03	**PROBABILITY**	5	3	3	4:1
4	SG4C04	**TESTING OF HYPOTHESIS**	5	3	3	4:1

Semester I

Course-I (STATISTICAL METHODS)

Module 1. Meaning, Scope and limitations of Statistics – collection of data, conducting a statistical enquiry – preparation of questionnaire – primary and secondary data – classification and tabulation – Formation of frequency distribution – diagrammatic and graphic presentation of data – population and sample –advantages of sampling over census – methods of drawing random samples from a finite population. (Only a brief summary of the above topics is intended to be given by the teacher. Detailed study is expected from the part of students). **12hrs**

Module 2. Measures of central tendency – Arithmetic mean-weighted arithmetic mean, medium, mode, geometric mean and harmonic mean, partition values – quartiles – deciles and percentiles**. 30hrs**

Module 3. Measure of dispersion – relative and absolute measures of dispersion, measures of dispersion – range – quartile deviation – mean deviation-standard deviation – Lorenz curve – skewness and kurtosis. **30 hours**

Semester II

Course-II Regression Analysis, Time Series and Index Numbers

Module 1. Fitting of curves of the form – linear, y=abx, y=aebx – correlation analysis – concept of correlation – methods of studying correlation – scatter diagram – Karl Pearson's correlation coefficient – concept of rank correlation and Spearman's rank correlation coefficient – regression analysis – linear regression – regression equations (concepts only – Derivations are beyond the scope of this syllabus). **30hrs**

Module 2. Index numbers, meaning and use of index numbers – simple and weighted Index numbers – price index numbers – Laspeyer's, Paasche's Marshall – Edgeworth and Fisher's index number – Test of good index number, chain base and fixed base index number – construction of cost of living index number. **20hrs**

Module 3. Time series analysis – component of time series – measurement of secular trend semi average, moving average and least square methods (linear function only) concept of seasonal and cyclical variation. **22hours**

Semester III

Course III-PROBABILITY

1. **Module 1.** Probability theory – concept of random experiment, sample point, sample space and events – mathematical and statistical definitions of probability, limitations, axiomatic approach to probability–addition and, multiplication theorems, concept of conditional probability, probability in discrete sample space – numerical problems. **35 hours**

2. **Module 2.** Random variable, definition of discrete and continuous type – probability mass function, distribution function – mathematical expectation, definition, numerical problems in the discrete case only. **25 hours**

3. **Module 3.** One point, two point, Bernoulli, binomial, Poisson. Normal distributions – probability density function, properties – simple numerical problems. **30hrs**

Semester IV

Course-IV-TESTING OF HYPOTHESIS

Module 1. Testing of statistical hypotheses, large and small sample tests, basic ideas of sampling distribution, test of mean, proportion, difference of means, difference of proportions, tests of variance and correlation coefficient, chi squares tests**. 35hours**

Module 2. Non parametric tests – advantages, sign test, run test, signed rank test, rank-sum test. Kolmogorov – Smirnov goodness of fit test. **30 hours**

Module 3. Analysis of variance: One way and two way classifications. Null hypotheses, total, between and within sum of squares. ANOVATable. Solution of problems using ANOVA tables. **25 hours**

Books for reference.

1. S.C. Gupta and V.K. Kapoor : Fundamentals of Mathematical Statistics, Sultan Chand and sons
2. Mood A.M., Graybill. F.A and Boes D.CIntroduction to Theory of
3. Gibbons J.D.: Non parametric Methods for Quantitative Analysis, McGraw Hill.
4. S.C. Gupta & V.K.Kapoor: Fundamentals of Applied Statistics, Sultan Chand & Sons.
5. Box, G.E.P. and G.M. Jenkins: Time Series Analysis, Holden –Day

STATISTICS: COMPLEMENTARY – I
SYLLABUS FOR BSc. PSYCHOLOGY (MAIN)
CUCCSSUG 2014 (2014 admission onwards)

Sem No	Course code	Course Title	Instructional Hours/week	Credit	Exam Hours	Ratio Ext: Int
1	PS1C01	**STATISTICAL METHODS**	4	3	3	4:1
2	PS2C02	**REGRESSION ANALYSIS, AND PROBABILITY**	4	3	3	4:1
3	PS3C03	**PROBABILITY DISTRIBUTIONS AND PARAMETRIC TESTS**	5	3	3	4:1
4	PS4C04	**NON PARAMETRIC TESTS AND ANALYSIS OF VARIANCE**	5	3	3	4:1

Semester-I STATISTICAL METHODS
Module 1. Pre-requisites.
A basic idea about data, its collection, organization and planning of survey and diagramatic representation of data is expected from the part of the students. Classification of data, frequency distribution, formation of a frequency distribution, Graphic representation *viz*. Histogram, Frequency Curve, Polygon, Ogives and Pie Diagram. **20hr**

Module 2. Measures of Central Tendency.
Mean, Median, Mode, Geometric Mean, Harmonic Mean, Combined Mean, Advantages and disadvantages of each average. **20hrs**

Module 3. Measures of Dispersion.
Range, Quartile Deviation, Mean Deviation, Standard Deviation, Combined Standard Deviation, Percentiles, Deciles, Relative Measures of Dispersion, Coefficient of Variation.

Module 4. Skewness and Kurtosis.
Pearson's Coefficient of Skewness, Bowley's Measure, Percentile Measure of Kurtosis. **16hrs**

Books for Study.

1. Gupta, S P (1988). Statistical Methods, Sultan Chand and Sons, New Delhi.
2. Gupta, S C and Kapoor, V K (2002). Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
3. Garret, H E and Woodworth, R S (1996). Statistics in Psychology and Education,
Vakila, Feffex and Simens Ltd., Bombay.

COURSE II -SEMESTER-II

REGRESSION ANALYSIS AND PROBABILITY

Module 1. Correlation and Regression.
Meaning, Karl Pearson's Coefficient of Correlation, Scatter Diagram, Calculation of Correlation From a 2-way table, Interpretation of Correlation Coefficient, Rank Correlation,

Module 2. Multiple Correlation and Regression.
Partial and Multiple Correlation Coefficients, Multiple Regression Equation, Interpretation of Multiple Regression Coefficients (three variable cases only). **16h**

Module 3. 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). **20hrs**

Module 4. Random Variables and Their Probability Distributions.
Discrete and Continuous Random Variables, Probability Mass Function, Distribution Function of a Discrete Random Variable. **16hrs**

Books for Study.

4. Gupta, S P (1988). Statistical Methods, Sultan Chand and Sons, New Delhi.
5. Gupta, S C and Kapoor, V K (2002). Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
6. Garret, H E and Woodworth, R S (1996). Statistics in Psychology and Education,
Vakila, Feffex and Simens Ltd., Bombay.

Semester-III

Course III -PROBABILITY DITRIBUTIONS AND PARAMETRIC TESTS

Module 1. Distribution Theory.
Binomial, Poisson and Normal Distributions, Mean and Variance (without derivations), Numerical Problems, Fitting, Importance of Normal Distribution, Central Limit Theorem. **25hrs**

Module 2. Sampling Theory.
Methods of Sampling, Random and Non-random Sampling, Simple Random Sampling, Stratified, Systematic and Cluster Sampling. **20hrs**

Module 3. Testing of Hypotheses.
Fundamentals of Testing, Type-I & Type-II Errors, Critical Region, Level of Significance, Power, *p*-value, Tests of Significance. Large Sample Tests – Test of a Single Mean, Equality of Two Means, Test of a Single Proportion, Equality of Two Proportions. **25hrs**

Module 4. Small Sample Tests.
Test of a Single Mean, Paired and Unpaired t-Test, Chi-Square Test of Variance, FTest for the Equality of Variance, Tests of Correlation. **20hrs**

Books for Study.

7. Gupta, S P (1988). Statistical Methods, Sultan Chand and Sons, New Delhi.

8. Gupta, S C and Kapoor, V K (2002). Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
9. Garret, H E and Woodworth, R S (1996). Statistics in Psychology and Education,
Vakila, Feffex and Simens Ltd., Bombay.

Semester-IV NON PARAMETRIC TESTS AND ANALYSIS OF VARIANCE

Course IV

Module 1. Chi-square Tests.
Chi-square Test of Goodness of Fit, Test of Independence of Attributes, Test of Homogeneity of Proportions. **25hrs**

Module 2. Non-Parametric Tests.
Sign Test, Wilcoxen's Signed Rank Test, Wilcoxen's Rank Sum Test, Run Test, Krushkal-Wallis Test. **20hrs**

Module 3. Analysis of Variance.
One-way and Two-way Classification with Single Observation Per Cell, Critical Difference. **25hrs**

Module 4. Preparation of Questionnaire, Scores and Scales of Measurement, Reliability and Validity of Test Scores. **20hrs**

Books for Study.

10. Gupta, S P (1988). Statistical Methods, Sultan Chand and Sons, New Delhi.
11. Gupta, S C and Kapoor, V K (2002). Fundamentals of Applied Statistics, Sultan
Chand and Sons, New Delhi.
12. Garret, H E and Woodworth, R S (1996). Statistics in Psychology and Education,
Vakila, Feffex and Simens Ltd., Bombay.

UNIVERSITY OF CALICUT

(Model Question Paper)

FIRST SEMESTER BSc DEGREE EXAMINATION (CCSS)

Core Course (ST1BO1). BASIC STATISTICS AND PROBABILITY

Time 3 hours Total 80 marks

Section A. One word questions. Answer all questions 10X1=10

1. How we call the representative part of the population?
2. Give name of two type of sampling methods
3. Write any two measures of dispersion
4. What is the relationship between AM, SD and CV
5. What is the method used for fitting curve
6. Give the limit of correlation coefficient
7. What is regression equation of y on x.
8. What is probability of sample space
9. Does the mutual independence imply pair wise independence
10. Does the distribution function F(x) increases?

Section B. One sentence questions. Answer all questions 7X2=14

11. Define AM of n observations?
12. Give two properties of SD
13. Define regression co-efficient
14. Write down axioms of probability
15. Write the properties of a distribution function
16. Define a random variable
17. What is meant by r^{th} central and raw moments

Section C. Paragraph questions. Answer any three questions 3X4=12

18. Explain different measures of dispersion

19. Prove correlation coefficient is unaffected by change of origin and scale.

20. Describe fitting of parabola

21. Prove addition theorem on probability for two events

22. Compute P(X<0.5) and P(X>0.9) from the distribution function

F(x) = 0 if x<0

= X^2 if 0<x<1

=1, if x>1

Section D. Short essay questions. Answer any four questions 4X6=24

23. Find the mean and variance of the first n natural numbers.

24. An integer is chosen at random from the first 100 integers. An event A is said

to happen if the chosen integer is divisible by 3 or 5. Write down the sample

space and the event A.25. A and B are independent events and if P(A) = 1/3 = P(B), what is P(AUB)?

26. Determine the constant k such that the function given below will be a pdf.

f(x) = 0 for x < 0 or x > 3

=x for $0 \le x \le 1/2$

=k for $1/2 \le x \le 3$

27. If X has uniform (0,1) distribution, find pdf of Y=-2log X

28. The two regression lines are $3x + 12y - 10 = 0$ and $3y + 9x - 46 = 0$. Find

(a) the means of X and Y.

(b) the correlation coefficient.

Section E. Essay questions. Answer any two questions 2X10=20

29. Derive spearman's formula for Rank correlation coefficient?

30. State and prove Boole's inequality

31. State and prove Bayes theorem

32. If

f(x)=ax if 0<x<5

=a(10-x), 5<x<10

=0 otherwise

Find a and P(X<7) and P(X>7)

University of Calicut

Model Question Paper

Second Semester BSc Degree Examination

Core-Course ST2B02 BIVARIATE RANDOM VARIABLE AND PROBABILITY DISTRIBUTIONS

Time 3 hour **Total: 80 marks**

Section A: One word question. Answer all questions

10x1=10

1. If X and Y are independent then what is the value of correlation coefficient.
2. If X and Y are two random variables with mean and respectively then E(X- is called.
3. Write down the limit of the correlation coefficient.
4. Write down the name of the distribution in which mean and variance are equal
5. Write down the name of distribution in which mean is less than variance.
6. If X is a random variable, is called.
7. Write down the expression for the central moment in terms of Expectation
8. Write down the limit form of Poisson distribution.
9. Write down the limit of gamma variate.
10. X~ what is the distribution of .

Section B: One sentence question. Answer all questions

7x2=14

11. Define mathematical expectation of a bivariate random variable
12. What is meant by Kurtosis.
13. Define correlation coefficient.
14. Define Pareto distribution.
15. Write the expression for moment generating function of Normal distribution.
16. Define conditional mean and variance.

17. Define Uniform distribution.

Section C: Paragraph question. Answer any three questions

3x4=12

18. Find the moment generating function of Binomial distribution.
19. State and prove the additive property of Normal distribution.
20. Define Negative binomial distribution. Find its mean.
21. Discuss Normal distribution and its properties.
22. What is the importance of standard normal variable.

Section D: Short easy questions. Answer any four questions

4x6=24

23. If X and Y are independent random variable, show that .
24. If X and Y are independent random variable, show that E(XY)=E(X) E(Y).
25. Define Geometric distribution. Find mean and variance. Also explain lack of memory property.
26. Find the moment generating function of Negative binomial distribution.
27. Explain lognormal distribution. Find the mean and variance.
28. Find the mode of Poisson distribution.

Section E: Essay question. Answer any two questions

2x10=20

29. Define Bivariate joint normal distribution. Find the marginal pdf. Show that if, then X and Y are independent.
30. Define Bivariate moments and conditional variance. Show that .
31. Define binomial distribution. Show that under certain conditions(to be satisfied) binomial distribution tends to Poisson distribution.
32. Explain Gamma distribution. Find the moment generating function. State and prove additive property.

THIRD SEMESTER B.Sc DEGREE EXAMINATION

(CCSS-Model Question Paper)

Statistics-Core Course

ST3B03- STATISTICAL ESTIMATION

Time: Three hours Maximum: 80 Mark

Part A

Answer All questions

1. Limiting distribution in Central Limit Theorem is.....
2. .....distribution has variance=2.mean
3. Square of standard Normal distribution is.....
4. If E(T)=parameter, then the statistics T is .....for parameter
5. The confidence interval for mean of Normal population is.....
6. Write down T-statistic
7. Does sample mean converges to population mean in Normal distribution
8. Is sample variance is convergent for population variance
9. MLE of Normal variance is.....
10. Give an example of efficient statistic

(10X1=10)

Part B

Answer All questions

11. State and prove weak Law of Large numbers
12. Find the distribution of sample mean of a Normal population
13. Find a sufficient statistic for Normal population variance
14. Obtain the MLE for Poisson parameter
15. Find a large sample Confidence Interval for mean
16. Show that sample mean is unbiased for population mean
17. Find the MLE for p in a Bernoulli distribution

(7X2=14)

Part C

Answer Any three questions

18. Prove Tchebyshev's inequality
19. Describe the relationship between chi-square, T and F distributions
20. Show that sample mean is the sufficient estimator for the Poisson parameter
21. Describe the method of moments
22. Obtain the exact confidence interval for mean when variance is known, of Normal population

(3X4=12)

Part D

Answer Any four questions

23. State and prove Bernoulli Law of Large Numbers
24. Define Sufficiency, Unbiasedness, efficiency and consistency of an estimator. Check whether sample mean of a sample from Normal population has all these properties.
25. Determine the distribution of sample variance of a Normal Population
26. State and prove Cramer Rao inequality
27. Describe various methods of Estimation with example.
28. Establish the relation between chi-square and t-distribution.

(4x6=24)

Part E

Answer Any two questions

29. Estimate mean and variance of Normal distribution by method of moments.
30. Derive confidence interval for variance of Normal Population
31. If $X_1, X_2, ...,X_n$ are independent Normal variables with mean 0 and variance 1. Find the distribution of $X_1+X_2+...+X_n$.
32. What is Standard Normal distribution. How do we get it from Normal distribution. How large a sample is to be taken from a Normal Population N(10,3), if the sample mean is to be lie between 8 and 12 with probability 0.95.

(2X10=20)

FOURTH SEMESTER B.Sc DEGREE EXAMINATION

(CCSS-Model Question Paper)

Statistics-Core Course

ST4B04- TESTING OF HYPOTHESIS

Time: Three hours Maximum: 80 Marks

Part A (10X1=10)

Answer All questions

1. Rejecting the null hypothesis when it is true is..... error
2. Power of the test is.....
3. When sample size is small, which test is used to test the mean
4. Name one use of chi-square test
5. ..... error is more serious
6. Write down a test based on F distribution
7. Test statistics of single sample t-test is.....
8. What is the Kolmogorov- Smirnov's single sample test statistic
9. Which non-parametric test is used to test equality of distribution
10. Write down the test statistic for testing equality of two populations

Part B (7X2=14)

Answer All questions

11. Define simple hypothesis
12. Differentiate between type 1 and type 2 errors
13. What are various small sample tests
14. Discuss F-test
15. What are the use of chi-square tests
16. Write two non-parametric tests
17. Write down test statistic for Mann-Whitney test

Part C(3X4=12)

Answer Any three questions

18. Define critical region and level of significance
19. Discuss t-test for equality of means
20. Describe chi-square test for independence of attributes
21. Write short note on Median Test
22. Explain the testing of variance of Normal population

Part D(4x6=24)

Answer Any four questions

23. A sample of 25data has a mean 57.6 and variance 1.8. A further sample of 20 data has mean of 55.4 and a variance 20.5. Test the hypothesis that two sample have same mean
24. A sample of size 25 from a Normal population with variance 8 produced a mean of 81.2. Find a 95% confidence interval for the sample mean
25. A sample of size 16 yields the following data: .59,.72,.47, .43, .31, .56, .22, .90, .96, .78, .66, .18, .73, .43, .58, .11. Test the hypothesis that mean is .78.
26. Let p be the probability that a coin will fall head in a single toss in order to test H_0 : p=0.5 against H_1 : p=.75. The coin is tossed 5 times and H_0 is rejected if more than 3 heads are obtained. Find the probability of type I error and power of the test.
27. Let X have an exponential distribution with parameter a, $f(x)=ae^{-ax}$, x>0. Test H_0 : a=.5 against H_1 : a=1 where the critical region is $\{9.5<x_1+x_2\}$. Find power of the test and significance level of the test.
28. A sample of size 1 is taken from pdf
    $f(x)=2(k-x)/k^2$, $0<x<k$. Find most powerful test of $k=k_0$ against k not equal to k_0

Part E(2X10=20)

Answer Any two questions

29. State Neyman Pearson Lemma. Use the lemma to obtain the best critical region for testing $a=a_0$ against $a=a_1$, in the case of a normal population with mean a and variance b. Find the power of the test.

30. Test whether the means of following samples are coming from same Normal population with equal mean (Assume equal variance)

X	13 14 10 11 12 16 10 8 11 12 9 12
Y	7 11 10 8 10 13 9

31. A personality test was conducted on a random sample of size 10 students from a large university and the following scores were obtained: 35, 60, 55, 50, 44, 41, 47, 49, 53, 50. Test whether the average personality test score is 55 at 5% level.

32. Fit a Poisson distribution for the following data and test the goodness of fit.

X	0	1	2	3	4	5	6
frequency	275	72	30	7	5	2	1

SECOND SEMESTER B.Sc. DEGREE EXAMINATION

Model Question Paper (2015 onwards)

(UG-CCSS)

Complementary Course

Statistics (Actuarial Science)

AS2C02-LIFE CONTINGENCIES

Time: Three Hours **Maximum: 80 Marks**

Part A

Answer all ***ten*** questions
Each question carries 1 mark

1. If Calculate
   a) b)
   c) d) none of these
2. Using AM92 mortality table, evaluate ${}_2P_{[30]}$.
   a) 0.8525 b) 0.0014
   c) 0.9989 d) 0.9214
3. If $_n$ and $_n$. Calculate $_n$
   a) 0.65 b) 0.25
   c) 0.15 d) 0.45
4. The future life time of (x) is denoted by ……..
   a) S(x) b) F(x)
   c) T(x) d) f(x)
5. Choose the correct notation for the n- year deferred whole life annuity due.
   a) b)
   c) d)
6. A …….. is a contract to pay a benefit if and when the policy holder is diagnosed as suffering from a particular disease.
7. An Endowment insurance is a combination of ……... and ……
8. The simplest life insurance contract is ……...
9. Events that depend upon the order in which the lives die are called …….
10. Find using (PFA92C20 at 4%).

(10 x 1= 10 Marks)

Turn Over

Part B

Answer all ***seven*** questions

Each question carries 2 marks

11. What does ${}_tP_{xy}$ mean?
12. Define curtate future life time.
13. Calculate the probability that a 50 year old dying between ages 68 and 70.
14. Define select mortality.
15. Prove the identity .
16. Define joint life status.
17. Define Survival function.

(7 x 2= 14 Marks)

Part C

Answer any ***three*** questions

Each question carries 4 marks

18. State UDD assumption.
19. Derive the commutation function for the n-Year Term assurance contract.
20. Calculate ${}_6P_{34}$ and ${}_4$using AM92 ultimate mortality (4% interest).
21. Write a note on Analytical Laws of Mortality.
22. Prove that ${}_n$

(3 x 4= 12 Marks)

Part D

Answer any ***four*** questions

Each question carries 6 marks

23. Calculate ${}_3P_{62.5}$ based on the PFA92C20 table in the table using
    i. The UDD assumption.
    ii. The CFM assumption.
24. Explain continuous Whole life Assurance contract. Find its mean and variance.
25. Calculate the following using AM92 ultimate mortality
    i. ${}_3P_{45:41}$
    ii.
    iii. .
26. Prove that ${}_n$ = ${}_n$
27. Explain n-year temporary life annuity.
28. Distinguish between complete expectation of life and curtate expectation of life.

(4 x 6= 24 Marks)

Part E

Answer any ***two*** questions

Each question carries 10 marks

29. Explain n year Endowment Assurance contract. Find its Mean and Variance.
30. Derive the relationship between Insurance payable at the moment of death and the end of the year of death.
31. A life insurance company issues a joint life annuity to a male, aged 68, and female, aged 65. The annuity of Rs.10000 per annum is payable annually in arrears and continues until both lives have died. The Insurance company values this benefits using PFA92C20 mortality (males or females as appropriate) and 4% p.a. interest.
    i. Calculate the expected present value of this annuity.
    ii. Derive an expression for the variance of the present of this annuity in terms of appropriate single and joint-life assurance functions.
32. Explain the following :
    a) Present values of joint life and last survivor assurance.
    b) Present values of joint life and last survivor annuities.

(2 x 10= 20 Marks)

THIRD SEMESTER B.Sc. DEGREE EXAMINATION

Model Question Paper (2015 onwards)

(UG-CCSS)

Complementary Course

Statistics (Actuarial Science)

AS3C03-LIFE CONTINGENCIES AND PRINCIPLES OF INSURANCE

Time: Three Hours **Maximum: 80 Marks**

Part A

Answer all ***ten*** questions

Each question carries 1 mark

33. The cause that produces loss is known as ……..
    b) Hazard b) Peril
    c) Risk d) none of these

34. Which of the following represents a risk seeking investor with respective the utility function U(w).
    b) U'(w) >0 b) U"(w)<0
    c) U"(w)>0 d) U"(w)=0

35. Calculate , if ${}_nV_x$=0.080, =0.024 and
    b) 0.08 b) 0.008
    c) -0.08 d) -0.008

36. Premiums are always paid in …….
37. ……. contract, under which benefits are paid for by a single lump sum premium paid at the time the contract is affected.
38. The contingent payment linked to the amount of loss is called….
39. Write down the form of log utility function.
40. The net premium is also called……..
41. The amount of money that the insurer sets aside to meet future liabilities is …
42. Write down the premium equation of h –payment whole life insurance

(10 x 1= 10 Marks)

Turn Over

Part B

Answer all ***seven*** questions

Each question carries 2 marks

43. Define pecuniary loss.
44. Define Apportionable premiums.
45. Define exponential utility function.
46. What you meant by a risk neutral investor?
47. Define Prospective reserve.
48. Define Aviation insurance.
49. What is valuation of the policy?

(7 x 2= 14 Marks)

Part C

Answer any ***three*** questions
Each question carries 4 marks

50. Explain utility theory.
51. Explain motor insurance.
52. 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.
53. 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 payble at the end of the year of death.
54. Explain why the insurer holds reserve?

(3 x 4= 12 Marks)

Part D

Answer any ***four*** questions
Each question carries 6 marks

55. Distinguish between Life Insurance and General Insurance.
56. Briefly explain Fire Insurance and Marine Insurance.
57. Explain benefit reserve under fully continuous Whole life Insurance.
58. Explain n-year temporary life annuity.
59. State and prove Jensen's Inequalities.
60. Consider a multiple decrement model with two causes of decrement, the forces of decrement are given by

Obtain expression for

a) b) c)

.

(4 x 6= 24 Marks)

Part E

Answer any ***two*** questions

Each question carries 10 marks

61. State and explain Thieles differential equation.
62. Explain the following:
    (i) Premium under n- year deferred whole life annuity.
    (ii) Premium under n-year endowment insurance.
63. Explain the various multiple decrement models.
64. a) Briefly explain the history of insurance India.
    b) Briefly explain Liability insurance.

(2 x 10= 20 Marks)

FOURTH SEMESTER B.Sc. DEGREE EXAMINATION

Model Question Paper (2015 onwards)

(UG-CCSS)

Complementary Course

Statistics (Actuarial Science)

AS4C04-PROBABILITY MODELS AND RISK THEORY

Time: Three Hours **Maximum: 80 Marks**

Part A

Answer all ***ten*** questions

Each question carries 1 mark

1. Which of the following is not true for random variable I with range ?
   c) Binomial R.V b) Bernoulli R.V
   d) Uniform R.V d) Indicator.
2. What is
   c) ∞ b) 1
   c) 0 d) none of these
3. If X has a Pareto distribution with parameters λ=400 and α=3, and N has a Poisson (50) distribution. Find the expected value of S.
   c) 50 b) 100
   c) 10000 d) 2000
4. Obtain the variance of the claim random variable X, where q=0.04 and the claim amount is fixed at 50.
   a) 0.12 b) 96
   c) .25 d) 0.2
5. The aggregate claim process is ……
   a) {N(t), t ≥0} b) {U(t), t ≥0}
   c) {S(t), t ≥0} d) none of these
6. Under Negative binomial distribution E[N] is …… Var[N].
7. Probability of ultimate ruin is denoted by……..
8. If S has a compound Poisson distribution given by λ=3, Calculate for x=0.
9. When the surplus falls below zero, it is said that …… has occurred.
10. Which distribution is reasonable fit for Automobile physical damage insurance?

(10 x 1= 10 Marks)

Turn Over

Part B

Answer all ***seven*** questions

Each question carries 2 marks

11. Suppose and. Find.
12. Define compound Poisson distribution.
13. Obtain the mean and variance of the claim random variable X, where q=0.06 and the claim amount is fixed at B.

14. Define adjustment coefficient.
15. What you meant by maximal aggregate loss?
16. Define the probability of ruin in finite time (continuous case).
17. Define Convolution.

(7 x 2= 14 Marks)

Part C

Answer any ***three*** questions
Each question carries 4 marks

18. Define inverse Gaussian distribution.
19. If the claims distribution with P(1)=P(2)=1/2, then determine θ if it is given that R=log3.
20. Suppose that N~Negbin (2, 0.8) and X~Gamma (4, 3). Find E[S] and V[S].
21. Determine the adjustment coefficient, if the claim amount distribution is exponential with parameter β>0.
22. Explain Translated Gamma Distribution.

(3 x 4= 12 Marks)

Part D

Answer any ***four*** questions
Each question carries 6 marks

23. 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.
24. The number of claims from a portfolio of policies has a Poisson distribution with parameter 30 per year. The individual claim amount distribution is lognormal with parameters and. The rate of premium income from the portfolio is 1,200 per year. If the insurer has an initial surplus of 1000, estimate the probability that the insurer's surplus at time 2 will be negative, by assuming that the aggregate claims distribution is approximately normal.
25. The probability of an automobile accident in a given time period is 0.001. If an accident occurs the amount of damage is uniformly distributed on the interval (0, 15000). Find the expectation and variance of the amount of damage.
26. Does the compound binomial distribution have an additive property? If so, state the property carefully.
27. 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.
28. If S has a compound Poisson distribution, then show that the distribution of converges to the standard normal distribution as λ tends to ∞.

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(4 x 6= 24 Marks)

Part E

Answer any ***two*** questions
Each question carries 10 marks

29. a) Show that sums of independent compound Poisson random variables is itself a
Compound Poisson random variable.
b) If N has a Poisson distribution with mean λ, show that
.

30. a) If X~ Poisson () and Y~ Poisson (μ) are independent random variables, find the probability function of Z=X+Y using convolutions.
b) A random variable U has M.G.F. . Use the MGF to calculate the mean and variance of U.

31. Consider a portfolio of 32 policies. For each policy; the probability q of a claim is 1/6 and b, the benefit amount given that there is a claim, has p.d.f.

Let S be the total claims for the portfolio. Using a normal approximation, estimate

32. Explain the surplus process.

(2 x 10= 20 Marks)