Scheme of Examinations for M.Sc. (Statistics) w.e.f. 2014-2015

The duration of the course leading to the degree of Master of Science (M.Sc.) Statistics shall be of two academic years. The course will be run under semester system. The examination of Semester –I and Semester- II will ordinarily be held in the month of December and that of Semester-II and Semester-IV in the month of May on the dates to be notified by the controller of examinations.

There will be five papers in each semester, four theory and one practical. In Semester-I & II all the papers will be compulsory. In Semester –III and IV out of four theory papers, two papers will be compulsory and the other two will be optional ones. The optional papers will be offered from the list given in the scheme provided the staff is available to teach them.

Each student will be required to give one test /seminar for each paper. and one class test for the purpose of internal assessment.
The details of the scheme of examination:

Semester-I

Sr.No.	Nomenclature of Paper	Max. Marks.	Time
Paper-1	Measure and Probability	80+20*	3 hrs.
Paper-II	Statistical Methods and Distribution Theory	80+20*	3 hrs.
Paper-III	Inference –I	80+20*	3 hrs.
Paper-IV	Applied Statistics	80+20*	3 hrs.
Paper-V	Practical (Calculator and SPSS/SYSTAT based)	80**+20*	4 hrs.

Semester –II

Paper-1	Demography	80+20*	3 hrs.
Paper-II	Operations Research	80+20*	3 hrs.
Paper-III	Inference -II	80+20*	3 hrs.
Paper-IV	Computer Fundamentals and Problem Solving Using C	80+20*	3 hrs.
Paper-V	Practical (Computer based)	80**+20*	4 hrs.

Semester-III

Paper-I	Sampling Theory	80+20*	3 hrs.
Paper-II	Object-Oriented Programming with C++	80+20*	3 hrs.
Paper-III &IV		80+20*	3 hrs.
Any two of the following options:			
Option (i)	Theory of Queues		
Option(ii)	Linear Programming		
Option(iii)	Stochastic Processes		
Option(iv)	Bio- Statistics		
Option (v)	Statistical Methods in Epidemiology		
Option (vi)	Statistical Ecology		
Paper-V	Practical (Computer based)	80**+20*	4 hrs

Semester -IV

Paper-I	Multivariate Analysis	80+20*	3 hrs.
Paper-II	Linear Estimation & Design of Experiments	80+20*	3 hrs.
Paper –III & IV		80+20*	3 hrs.

Any two of the following options:

Option(i)	Reliability and Renewal Theory
Option(ii)	Non- Linear and Dynamic Programming
Option (iii)	Information Theory
Option (iv)	Game Theory
Option (v)	Econometrics
Option (vi)	Acturial Statistics

Paper-V	Practical (Calculator and SPSS/SYSTAT based)	80**+20*	4 hrs.

** The division of Max. Marks for Practical papers is as follows:

Practical	:	60 marks
Class Record	:	10 marks
Viva-Voce	:	10 marks

*The marks of internal assessment will be based on the following criteria:-

For Theory Papers:

(i)	One test/ Seminar for each paper	: 50%
(ii)	One Class Test (One period duration)	: 25%
(iii)	Attendance ***	: 25%

For Practicals:

(i)	One Seminar/Test/ Viva/ Sessional for each paper	: 50%
(ii)	One Class Test (One period duration)	: 25%
(iii)	Attendance***	: 25%

***** Marks for attendance will be given as under:**

(1) 91% onwards: 5 marks **(2)** 81% to 90%: 4 marks
(3) 75% to 80%: 3marks **(4)** 70% to 74%: 2 Marks
(5) 65% to 69%: 1 Mark

M.Sc. Statistics Semester - I

Paper – I **Measure and Probability** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all selecting one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit –I

Fields; sigma field, sigma-field generated by a class of subsets, Borel fields. Sequence of sets, limsup and liminf of sequence of sets, random variables, distribution function. Measure, probability measure, properties of a measure, Concept of outer measures, inner measures, lebesgue measures, concept of Lebesgue-Stieltjes measure.

Unit –II

Measurable functions, sequence of measurable functions; their convergence of various types. Integration of measurable function. Monotone convergence theorem. Fatou's Lemma. Dominated convergence theorem, Product measure, Fubin's Theorem.

Unit –III

Borel-Contelli Lemma, Tchebycheff's and Kolmogorov's inequalities, various modes of convergence: in probability, almost sure, in distribution and in mean square and their inter-relationship.

Unit –IV

Laws of large numbers for i.i.d. Sequences. Characteristic function its uniqueness, continuity and inversion formula. Applications of characteristic functions. Central limit theorems: De Moivre's-Laplace, Liapounov, Lindeberg-Levy and their applications

References:

1. Kingman, J. F. C. & Taylor, S.J. (1966). : Introduction to Measure and Probability, Cambridge University Press.
2. Bhat, B.R. : Modern Probability Theory, Wiley Eastern Limited
3. Taylor, J. C. : An Introduction to Measure and Probability, Springer.
4. Royden, H.L. : Real Analysis, Pearson Prentice Hall.
5. Billingsley, P. (1986). : Probability and Measure, Wiley.
6. Halmos, P.R. : Measure Theory, Springer
7. Basu,A.K. : Measure Theory and Probability,PHI Learning(Pt.Lim.)

M.Sc. Statistics Semester - I

Paper-II **Statistical Methods and Distribution Theory** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Basic concepts of probability: Random variable, sample space, events, different definitions of probability, notations, distribution functions. Additive law of probability, theorem of total probability, theorem of compound probability and Baye's theorem. Concept of bivariate, marginal and conditional distributions.

Unit-II

Mathematical Expectation : Expectation and moments, expectation of sum of variates, expectation of product of independent variates, moment generating function. Tchebycheff's, Markov , Jensen and Holder and Minkowski inequalities, Covariance, correlation coefficient , rank correlation, regression lines partial correlation coefficient, multiple correlation coefficient . Relation between characteristic function and moments.

Unit – III

Binomial, Poisson, Geometric, Negative binomial, Hypergeometric and Multinomial, Normal and log normal distributions.

Unit –IV

Uniform, Exponential, Cauchy, Beta, Gamma distribution, Sampling distributions: Student - t distributions, F- distribution, Fisher's z – distribution and Chi-square distribution. Inter relations, asymptotic derivations. Simple tests based on t, F, chi square and normal variate z.

References:

1. Feller, W. : Introduction to probability and its applications, Vol.I, Wiley
2. Parzen, E. : Modern Probability Theory and its Applications, Wiley Interscience
3. Meyer, P.L. : Introductory Probability and Statistical Applications, Addison wesely.
4. Cramer, H. : Random variable and Probability Distribution, Cambridge University Press.
5. Kapur, J.N. Sexena, H.C. : Mathematical Statistics & S.Chand & Co.

M.Sc. Statistics Semester - I

Paper – III **Inference -I** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit – I

Elements of Statistical Inference. Concept of likelihood function. Point estimation. Concept of consistency, unbiased estimators, correction for bias, minimum variance estimator, Cramer - Rao inequality, Minimum Variance-Bound (M.V.B.) estimator, Bhattacharya Bounds, Uniqueness of minimum variance estimators, efficiency, Minimum-mean-square estimation.

Unit – II

Sufficient statistic , sufficiency and minimum variance. Rao- Blackwell theorem. Distributions possessing sufficient statistics. Sufficiency when range depends on the parameter. Least squares method of estimation and its properties.

Unit – III

Methods of estimation : Method of moments, Method of minimum chi-square, Method of maximum likelihood estimators and their properties, sufficiency, consistency of ML estimators. Hazurbazar's theorem, unique consistent ML estimators, efficiency and asymptotic normality of ML estimators.

Unit – IV

Interval estimation : Confidence intervals, confidence statements , central and non-central intervals , confidence intervals, Most selective intervals , Fiducial intervals : Fiducial inference in student's distribution , Problem of two means and its fiducial solution . Exact confidence intervals based on student's distribution, Approximate confidence- intervals solutions. Ideas of subjective probability, prior and posterior distribution, Bayesian intervals, Discussion of the methods of interval estimation.

References:

1. Kendall and Stuart : Advanced Theory of Statistics Vol.-II, Charles Griffin Co .Ltd London.
2. Rohtagi,V.K. : Introduction to probability Theory and Mathematical Statistics (for Numerical and Theoretical Applications), John Wiley and Sons.
3. Wald, A: : Sequential Analysis, Dover publications, INC, New York.
4. Rao, C.R. : Advanced Statistical Methods in Biometric Research. John Wiley &Sons, INC, New York.

M.Sc. Statistics Semester - I

Paper IV **Applied Statistics** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit- I

Analysis of time Series, Trend measurement ; use of polynomial, logistic, Gompertz and lognormal functions . Moving average method, Spencer's formulae; variate difference method, its use for estimation of variance of the random component. Measurement of seasonal fluctuations, measurement of cyclical movement.

Unit- II

Periodogram analysis. Concept of stationary time series, correlogram analysis, correlogram of an autoregressive scheme, a moving average scheme and a Harmonic series. Statistical quality control and its purposes; 3 sigma control limits, control charts for variables (mean and range, mean and standard deviation) Control chart for fraction defective, control chart for the number of defects per unit.

Unit- III

Natural tolerance limits and specification limits; Modified control limits. Sampling Inspection Plan : Concepts of Acceptance quality level (A.Q.L) ,Lot tolerance proportion defective (LTPD)and indifference quality. The single and double sampling plans, and their four curves viz, AOQ, Operating characteristic (OC), Average Sample Numper (ASN) and Average Total Inspection (ATI) curves.

Unit- IV

Sequential sampling plan and its AOQ, OC, ASN and ATI. The choice of sampling plans by attributes and by variables. Acceptance Sampling plan by variables, single and sequential Sampling Plans, acceptance sampling by variables (known and unknown sigma cases.)

References:

1. Kendall, M.G. : Time Series,Griffin London
2. Gupta, S.C. & Kapoor, V.K. : Fundamentals of Applied Statistics, Sultan Chand and Sons.
3. Ekambaram, S.K. : The Statistical Basis of Acceptance Sampling, Asia Publishing House.
4. Goon, A.M., Gupta, M.K. & Dasgupta, B. : Fundamentals of Statistics, Vol. II, ed. VI, Word Press Calcutta 1988
5. Cooray, T.M.J.A. : Applied Time Series –Analysis and Forecasting, Narosa Publishing House
6. Hansen, B.L. & Ghare, P.M. : Quality Control and Application, PHI. 1987.
7. Montgomery, D.C. : Introduction to Statistical Quality Control, J. Wiley. 1985
11. Gowden, D.J. : Statistical Methods in Quality Control, Prentice Hall.
12. Grant, E.L. : Statistical Quality Control, Wiley Eastern.
13. Duncan, A.C : Quality Control and Industrial Statistics, Richard O.Irwin, Homewood.IL

M.Sc. Statistics Semester – I

Paper-V Practical (Calculator and SPSS/SYSTAT based) **Max Marks : 80**+20***

**** Practical : 60**
Class Record : 10
Viva-Vice : 10
*** Internal Assessment**
Time: 4 hrs.

Note: There will be 4 questions, candidates will be required to attempt any 3 questions.

List of Practicals:

1. Testes of significance based on t distribution.
   (i) Testing the significance of the mean of a random sample from a normal population.
   (ii) Testing the significance of difference between two sample means,
   (iii) Testing the significance of an observed correlation coefficient.
   (iv) Testing the significance of an observed partial correlation coefficient.
   (v) Testing the significance of an observed regression coefficient.

2. Tests based on F distribution.
   (i) Testing the significance of the ratio of two independent estimates of the population variance.
   (ii) Testing the homogeneity of means (Analysis of variance).

3. Testing the significance of the difference between two independent correlation coefficients.

4. Testing the significance for
   (i) A single proportion
   (ii) Difference of proportions for large samples.

5. Obtaining confidence or fiducial limits for unknown mean.
6. Testing the significance of the difference between means of two large samples.
7. Testing the significance of difference between standard deviations of two large samples.
8. Estimation of parameters of Distributions by
   i. Method of moments.
   ii. Method of least squares.
   iii. Method of Modified minimum χ^2.
   iv. Maximum likelihood estimators.
9. Fitting of the
   (i) Binomial distribution
   (ii) Poisson
   (iii) Normal distribution
   and their test of goodness of fit using χ^2 test.
10. Correlation and regression
   (i) Pearson's coefficient of correlation
   (ii) Spearman's rank correlation coefficient (with ties and without ties).
   (iii) Fitting of the lines of regression.

11. Multiple and partial correlations
    (i) Multiple correlation coefficients
    (ii) Partial correlation coefficients
    (iii) Fitting of regression plane for three variates

12. Time series and SQC
    a. To obtain trends by using
        (i) Method of Semi-Averages
        (ii) Method of curve fitting
        (iii) Method of moving average.
        (iv) Spencer's 15 - point and 21 point - formulas.
    b. To obtain seasonal variation indices by using
        (i) Ratio to trend method.
        (ii) Ratio to moving average method.
        (iii) Link relative method.

    c. To construct

        (i) $\bar{X}$ and R–chart (ii) p–chart (iii) c–chart
        and comment on the State of control of the process.

M.Sc. Statistics Semester - II

Paper –I **Demography** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit –I

Methods of obtaining demographic data, Rates and ratios, measurement of population at a given time , measurement of mortality : crude death rate , specific rates ,infant mortality rate , prenatal mortality rate , standard death rates .Life tables : Construction of a complete life table and its uses.

Unit –II

Abridged life tables : Kings method , Reed and Merrell's method, Greville's method, Keyfitz and Frauenhal's method and Chiang's method . Measurement of fertility : Crude birth rate , general fertility rate , age specific fertility rate , total fertility rate , gross reproduction rate and net reproduction rate .

Unit –III

Structure of populations: Stable and quasi-stable population, Fundamental equation of stable population theory , intrinsic rate of growth , intrinsic birth and death rates , intrinsic age distribution , Leslie's model of population growth .

Unit –IV

Population Projection : Projected values & estimates, method of Projection , population size , population composition , survival rates : UN model life table ,model life tables of Coale and Demeny, Ledermann's model life tables, Brass model.

References:

1. Ramakumar, R. : Technical Demography, Wiley, Eastern Limited.
2. Gupta, S.C. & Kapoor, V.K. : Fundamental of applied Statistics, 1990. Sultan Chand and Sons, Ch. 9 only.
3. Benjamin,B. (1969) : Demographic Analysis, George, Allen and Unwin.
4. Cox, P.R. (1970). : Demography, Cambridge University Press.
5. Keyfitz, N (1977). : Applied Mathematical Demography; Springer Verlag.
6. Spiegelman, M. (1969). : Introduction to Demographic Analysis; Harvard University

M.Sc. Statistics Semester-II

Paper-II **Operations Research** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit –I

Linear Programming : Basic concepts convex sets, Linear Programming problem (LPP), Examples of LPP, Hyperplane, Open and Closed half spaces. Feasible, basic feasible and optimal solutions, Extreme points and graphical method. Simplex method. Duality in linear programming

Unit –II

Transportation and Assignment problems. (Computational Techniques only).
Decision Theory : Algorithm for decision based problems, Types of decision making, Decision making under uncertainty : Criterion of optimism , Criterion of pessimism and Hurwicz criterion . Decision making under risks: EVM, EOL and decision tree techniques.

Unit-III

Game Theory : Terminology , two person zero sun game; game of pure strategy , game of mixed strategy , reducing game by dominance, linear programming method.
Replacement models: replacement of items whose efficiency deteriorates with time and (i) The value of the money remains same during the period (ii) The value of the money also changes with time. Criterion of present value for comparing replacement alternatives.

Unit – IV

Inventory models: Deterministic inventory models (D.I.M) with no shortages: Basic EOQ model , EOQ with several runs of unequal lengths , EOQ with finite replenishment
D.I.M. with shortages : E O Q with instantaneous production and variable (fixed) order cycle time., EOQ with finite production EOQ with price breaks : E.O.Q with one price break. Simple Multi-item deterministic inventory model, model with limitation on space, model with limitation on investment. Queueing models : Introduction of queueing models, steady state solution of M/M/1 , M/M/1/N , M/M/C and M/M/C/N and their measures of effectiveness. CPM (Critical path method) to solve the network problems and PERT.

References:

1. Hadley, G. : Linear Programming, Narosa Publications House.
2. Churchman, C.W.. : Introduction to Operations Research John Wiley& Sons New York.
3. Goel, B.S. & Mittal, S.K.: Operations Research, Pragater Prekshlen, John & Sons.
4. Gross, D. & Harris, C.M. : Fundamentals of Queuing Theory Wiley.
5. Allen, A.O : Probability Statistics & Queuing Theory With Computer Science Applications (Academic Press) INC. Elsevier Direct.

M.Sc. Statistics Semester - II

Paper – III **Inference -II** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit – I

Elements of Statistical decision theory. Neyman - Pearson lemma (with emphasis on the motivation of theory of testing of hypothesis) BCR and sufficient statistics. Testing a simple hypothesis against a class of alternatives. Uniformly most powerful test and sufficient statistics, power function. One and two sided tests.

Unit –II

Likelihood ratio test and its applications, asymptotic distribution of LR statistic and asymptotic power of LR tests. An optimum property of sufficient statistics. Similar regions, Elementary ideas of complete statistics, Completeness of sufficient statistics. Sequential Analysis. Concept of ASN and OC functions. Wald's sequential probability ratio test and its OC and ASN functions.

Unit –III

Non - parametric tests and their applications. Tests of randomness, The Sign test and Signed-rank test. Goodness of fit problem: Chi-square and Kolmogrov- Smirnov tests, Independence in Bivariate sample: Kendall's Tau coefficient and Spearman's rank correlation.

Unit –IV

Generalized two-sample problem: The Wald-Wolfowitz Runs test, Kolmogrov-Smirnov two sample Test, Median Test, Mann-Whitney U Test, Linear Ranked tests for the Location and Scale problem: Wilcoxon Test, Mood Test, Siegel-Tukey Test, Klotz Normal-scores Test, Sukhatme Test.

References:

1. Kendall and Stuart : Advanced Theory of Statistics Vol.-II, Charles Griffin & Co. Ltd, London
2. Rohtagi,V.K. : Introduction to probability Theory and Mathematical Statistics(for Numerical and Theoretical Applications).
3. Wald, A : Sequential Analysis Dover Publications, INC. New York.
4. Gibbons, Jean Dickinson : Nonparametric Statistical Inference (For Unit - IV only). McGraw – Hill Book Co. New York.
5. Rao, C.R. : Advanced Statistical Methods in Biometric Research, John Wiley& Sons, INC, New York.

M.Sc. Statistics Semester - II

Paper –IV

COMPUTER FUNDAMENTALS AND PROBLEM SOLVING USING C

Max Marks: 80+20*
*Internal Assessment
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

UNIT – I

Computer Fundamentals: Definition, Block Diagram along with Computer components, characteristics & classification of computers, hardware & software, types of software.
Techniques of Problem Solving: Flowcharting, decision table, algorithms, Structured programming concepts.

UNIT – II

Overview of C: History of C, Importance of C, Structure of a C Program.
Elements of C: Character set, identifiers and keywords, Data types, Constants and Variables.
Operators: Arithmetic, relational, logical, bitwise, unary, assignment and conditional operators and their hierarchy & associativity. Input/output: Unformatted & formatted I/O function in C.

UNIT – III

Control statements: Sequencing, Selection: if and switch statement; alternation, Repetition: for, while, and do-while loop; break, continue, goto statement.
Functions: Definition, prototype, passing parameters, recursion.
Storage classes in C: auto, extern, register and static storage class, their scope, storage and lifetime.
Arrays: Definition, types, initialization, processing an array, passing arrays to functions.

UNIT – IV

Pointers: Declaration, operations on pointers, use of pointers. String handling functions
Structure & Union: Definition, processing, Structure and pointers, passing structures to functions.
Data files: Opening and closing a file, I/O operations on files, Error handling during I/O operation.

References

1. Sinha, P.K. & Sinha, Priti, Computer Fundamentals, BPB
2. Dromey, R.G., How to Solve it By Computer, PHI
3. Gottfried, Byron S., Programming with C, Tata McGraw Hill
4. Balagurusamy, E., Programming in ANSI C, McGraw-Hill
5. Jeri R. Hanly & Elliot P. Koffman, Problem Solving and Program Design in C, Addison Wesley.
6. Yashwant Kanetker, Let us C, BPB
7. Norton, Peter, Introduction to Computer, McGraw-Hill
8. Leon, Alexis & Leon, Mathews, Introduction to Computers, Leon Tech World

M.Sc. Statistics Semester – II

Paper-V **Practical (Computer based)**

Max Marks : 80+20***
**** Practical : 60**
Class Record : 10
Viva-Vice : 10
*** Internal Assessment**
Time: 4 hrs.

Note: There will be 4 questions, candidates will be required to attempt any 3 questions.

List of Practicals based **on C**

1. Finding the mean and standard deviation for discrete and continuous data.
2. Computation of Moments, Skewness and Kurtosis of given data.
3. Computation of Karl Pearson's, partial & multiple correlation coefficient and Spearman's rank correlation coefficient.
4. Curve fitting, fitting of lines of regression.
5. Fitting of distribution: Binomial, Poisson and Normal.
6. Testing the significance of the mean of a random sample from a normal population.
7. Testing the significance of difference between two sample means,

8 Testing the significance of an observed correlation coefficient.

09. Testing the significance of an observed partial correlation coefficient.

10. Testing the significance of an observed regression coefficient.

11. Testing the significance of the ratio of two independent estimates of the population variance.

M.Sc. Statistics Semester - III

Paper –I **Sampling Theory** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit -I

Basic finite population sampling techniques: Simple random sampling with replacement, Simple random sampling without replacement, Stratified sampling, Systematic sampling and related results on estimation of population mean/total, Relative precision of different sampling techniques, Allocation problem in stratified sampling.

Unit –II

Use of supplementary information: Ratio estimation, bias and mean square error, estimation of variance, comparison with SRS, ratio estimator in stratified sampling, unbiased ratio-type estimators, regression and difference estimators, comparison of regression estimator with SRS and ratio estimator, Two-stage sampling.

Unit –III

Sampling and sub-sampling of clusters. Single stage cluster sampling. Estimation of proportions, estimation of efficiency of clustering, Multistage sampling, Stratified multi stage sampling. Double Sampling: for difference estimation, for unbiased ratio estimation, for regression estimation, for stratification.

Unit –IV

Repetitive surveys: Sampling over two occasions, sampling over more than two occasions, probability proportionate to sampling (PPS) with replacement and without replacement methods [Cumulative total and Lahiri's method] and related estimators of a finite population mean[Horvitz Thompson estimator, Yates and Grundy estimator, Desraj estimators for a general sample size and Murthy's estimator for a sample of size two].

References:

1. Chaudhuri A and Mukerjee R.(1988) : Randomized Response, Theory and Techniques, New York : Marcel; Dekker Inc.
2. Cochran W.G. : Sampling Techniques (3rd Edition, 1977), Wiley.
3. Des Raj and Chandak (1998) : Sampling Theory, Narosa Publications House.
4. Murthy.M.N (1977) : Sampling Theory & Statistical Methods Publishing Society, Calcutta.
5. Sukhatme et atl (1984). : Sample Theory of Surveys with Applications. lowa State University Press & IARS.

M.Sc. Statistics Semester - III

Paper –II OBJECT-ORIENTED PROGRAMMING WITH C++ Max Marks: 80+20*

*Internal Assessment

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Object-Oriented Programming: Basic Concepts of OOP, Principles of OOP, Benefits of OOP, Applications of OOP, Structure of C++ Program, Identifier and key-words, Data types, variables, Operators and expressions in C++, Input and output operations, Control statements: If statement, if else statements, Nested if statements and switch statement. Loops: Do loop, while loop, Do-while loop and FOR loop. Functions: Prototypes, reference arguments, Inline functions. Arrays : one-dimensional, multidimensional arrays, Structures.

Unit –II

Classes and Objects: Classes, member function, inline member function, objects, access specifiers: public, private and protected, Static class members, friend function, Constructor and destructor: Constructor, parameterized constructor, copy constructor, destructor. Operator overloading: Function overloading, operator overloading, type conversions.

Unit – III

Inheritance in C++: types of inheritance, container classes, virtual base class, abstract class, constructor in derived classes. Pointers, Virtual functions and polymorphism: polymorphism, early binding, polymorphism with pointers, virtual functions, late binding, pure virtual functions.

Unit-IV

Streams and File processing: Streams classes, opening and closing a file, file modes, file pointers and their manipulation, sequential files, random files. Errors handling, Exception handling features.

References

1. Bjarne Stroustrup, The C++ Programming Language, Pearson
2. Herbert Scildt, C++, The Complete Reference, Tata McGraw-Hill
3. Robert Lafore, Object Oriented Programming in C++,
4. Lippman, C++ Primer, 3/e, Addison-Wesley
5. Balaguruswami, E., Object Oriented Programming In C++, Tata McGraw-Hill

M.Sc. Statistics Semester - III

Paper –III & IV Opt. (i) **Theory Of Queues** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Queueing system. Components of a queueing system, measures of effectiveness, notations, exponential distribution and its various properties, stochastic processes, definition and examples, Poisson process and its some important properties related to queues. Markov chains and its properties (without proof). Concepts of steady state and transient state, K-Erlang distribution. Birth and death process.

Unit-II

M/M/1 queueing system steady state and time dependent solutions. measures of effectiveness, busy period distribution, 'waiting time distribution, Little's formula. State probability generating function for M/M/1/N queueing system and its steady state probabilities measures of effectiveness, Time dependent solutions of M/M/∞ queuing system and M/M/∞ queueing system with time dependent input parameter, measures of effectiveness, M/M/1 queueing system with phase type service, busy period time distribution, waiting time distribution.

Unit-III

Non-primitive M/M/1/∞ queueing system with two priority classes. Mu1tiple channel queueing system with Poisson input and constant service time (M/D/C), Measures of effectiveness. Erlang service model $M/E_k/1$, Erlang arrival model $E_k/M/1$.

Unit-IV

Departure point steady state system size probabilities for M/G/1 queueing system, special cases $M/E_k/1$ and M/D/1 Pollaczek-Khintchine formula, waiting time, busy period analysis. Arrival point steady state system size probabilities for GI/ M/1 queueing system. Machine interference Model

References:

1. Gross, D. & Harris C.M : Fundamental. of queuing theory, John Wiley and Son..
2. Saaty, T.L. : Elements of queueing theory with app lications. McGraw Hill Book Company Inc.
3. Allen, A.O. : Probability, Statistics and Queuing Theory with Computer Science Applications, Academic Press
4. Kashyap, B.R.K & Chaudhary, M.L. : An Introduction to Queueing Theory, AARKAY Publications, Calcutts.

M.Sc. Statistics Semester - III

Paper –III & IV Opt. (ii) **Linear Programming** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Introduction : Theory of simplex method; Slack and surplus variables, Reduction of any feasible solution to Basic feasible solution, Improving a BFS, Unbounded solutions, Optimal conditions, Computational aspects of the simplex method :Selection of the vector to enter the basis , Degeneracy and breaking the ties, Transformation formulas,Artificial Variables, Inconsistency and Redundancy, Tableau format. The two phase method for artificial variables, Unrestricted variables.

Unit-II

Resolution of degeneracy problem: Charne's perturbation method, use of perturbation technique and simplex tableau format. The generalized linear programming problems, Generalized simplex method. The revised simplex method: Standard from I and II. Computational procedure for standard from I and II. Comparison of Simplex and revised Simplex method.

Unit-III

Duality theory : Dual linear programming problem, Fundamental properties of dual problems, complementary Slackness, Unbounded solution in the primal , Dual algorithm , Alternative derivation of dual simplex algorithm, Initial solution for dual simplex algorithm, a primal dual algorithm.

Unit –IV

Transportation problem, simplex method and transportation problem, transportation problem tableau, the stepping stone algorithm , Degeneracy and the transportation tableau, Determination of an initial basic feasible solution, Generalised transportation problems and their solutions. Applications of linear programming to industrial problems. Production allocation and transportation, Machine assignment problem , Regular time and over time production , optimal product mix and activity levels, Petroleum - refinery operations, Blending problems.

References:

1. Hadley, G. : Linear programming, Narosa Publications House.
2. Vejda, S. : Mathematical Programming, Dover Publications.
3. Saul E.Gauss. : Linear programming Methods and Applications, Dover Publications.
4. Kambo, N. S. : Mathematical Programming Techniques, East –West Press Pvt. Ltd.
5. Mittal, K.V. : Optimization Methods, New Age International (P) Ltd.

M.Sc. Statistics Semester - III

Paper –III & IV Opt. (iii) **Stochastic Processes** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

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Unit-I

Introduction to Stochastic processes, Classification of Stochastic processes according to state, space and time domain. Generating function, Convolutions, Compound distribution, Partial fraction expansion of generating functions.

Unit-II

Recurrent events, recurrence time distribution: necessary and sufficient condition for persistent and transient recurrent events & its illustrations and Notion of delayed recurrent event. Random walk models : absorbing, reflecting and elastic barriers, Gambler's ruin problem, probability distribution of ruin at nth trial.

Unit-III

Markov chains: transition probabilities, classification of states and chains, evaluation of the n^{th} power of its transition probability matrix. Discrete branching processes, chance of extinction, means and variance of the n^{th} generation.

Unit-IV

Notions of Markov processes in continuous time and Chapman-Kolmogorov equations. The Poisson process: The simple birth process, the simple death processes. The simple birth and death process: The effect of immigration on birth and death process. The Polya Processes: Simple non-homogeneous birth and death processes.

References:

1. Bailey, N.T : The Elements of Stochastic Processes.(1964 Ed.)
2. Medhi , J. : Stochastic Processes, New Age International (P) Limited
3. Karlin , S. : Introduction to Stochastic Processing, Vol. I, Academic Press.
4. Karlin, S. : Introduction to Stochastic Modeling, Academic Press.
5. Basu, A.K. : Introduction to Stochastic Process, Narosa Publishing House.

M.Sc. Statistics Semester - III

Paper –III & IV Opt. (iv) **Bio-Statistics** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

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Unit-I

Bioassays : Quantitative and quantal response, dose response relation. estimation of median effective dose, estimation of unknown concentration or potency, probit and logit transformations, Parallel line and slope ratio assays , potency, ratio, Feller's theorem. Tests for non-validity, symmetric and asymmetric : assays, Toxic action of mixtures.

Unit-II

Types of mating: Random mating, Hardy-Weinberg equilibrium, Random mating in finite population. Inbreeding (Generation Matrix Approach) Segregation and linkage. Estimation of segregation and linkage parameters

Unit-III

Concept of gen frequencies. Estimation of gene frequencies Quantitative inheritance, Genetic parameters heritability, genetic correlation and repeatability methods of estimation. Selection and its effect, Selection Index, dialled and partially dialled Crosses.

Unit-IV

Genotype environment interactions. Components of variance and Genotypic variance, Components of Covariance, Correlations between relatives, Genetic parameters; Heritability, Repeatability

References:

1. Kempthorne, O : An Introduction to Genetical Statistics, Wiley Eastern
2 Jain, l.R. (1982) : Statistical techniques in quantitative genetics. Tata-McGraw Hill
3. Poti, S.J. (1983) : Quantitative study in life sciences, Vikas Publishing Ltd.
4. Prem Narain; Bhatia : Handbook of Statistical Genetics, V.K. and Malhotra, I.A.S.R.I.P.K. (1979)
5. Daniell, W.W : Bio Statistics – A foundation for analysis in health sciences , 3rd ed. John wiley
6 Falconer, D.S. : Introduction to quantitative Genetics (Longman Group Ltd.)

M.Sc. Statistics Semester – III

Paper –III & IV Opt. (v) **Statistical Methods in Epidemiology**

Max Marks: 80+20*
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Measures of disease frequency: Mortality/Morbidity rates, incidence, rates, prevalence rates. Sources of mortality/Morbidity statistics-hospital records, vital statistics records. Measures of accuracy or validity, sensitivity index, specificity index.

Unit-II

Epidemiologic concepts of diseases, Factors which determine the occurrence of diseases, models of transmission of infection, incubation period, disease spectrum and herd immunity. Observational studies in Epidemiology: Retrospective and prospective studies. Measures of association :Relative risk, odds ratio, attributable risk.

Unit-III

Statistic techniques used in analysis: Cornfield and Garts' method, Mantel.Haenszel method. Analysis of data from matched samples, logistic regression approach.
Experimental Epidemiology: clinical and community trials. Statistical Techniques: Methods for comparison of the two treatments. Crossover design with Garts and Mcnemars test. Randomization in a clinical trial, sequential methods in clinical trials. Clinical life tables,

Unit-IV

Assessment of survivability in clinical trials. Mathematical Modelling in Epidemiology: simple epidemic model, Generalized epidemic models, Reed First and Green wood models, models for carrier borne and host vector diseases.

References:

1. Lilienfeld and LiJenfeld : Foundations of Epidemiology, Oxford University Press.
2. Lanchaster, H.O. : An Introduction to Medical Statistics, John Wiley & Sons Inc.
3. FIeiss, J.L. : Statistical Methods for Rates and Proportions, Wiley Inter Science.
4. Armitage : Sequential Medical Trials, Second Edition,Wiley Blackwell.
5. Bailey, N.T.J. : The mathematical theory of infectious disease and Applications, Griffin.

M.Sc. Statistics Semester - III

Paper –III & IV Opt. (vi) **Statistical Ecology** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Population Dynamics: Single species -exponential logistic and Gompertz models, two species competition and competitive exclusion, Predator-pray interaction, Lotka- Volteria equations.

Unit-II

Estimation of Abundance: Capture-recapture method, Line transect methods, nearest neighbour and nearest individual distance methods.

Unit-III

Analysis of bird ring recovery data, open and closed populations. Survivorship Models: Discrete case-life table, Leslie matrix. Continuous case survivorship curve, hazard rate, life distribution with monotone and non-monotone hazard rates.

Unit-IV

Ecological community: Species abundance curve, broken stick model. Diversity and its measures. Renewable Resources': Maximum sustainable yield, maximum economic yield, optimal harvesting strategy.

References:

1. Begin M, and Mortiner, M. : Population Ecology, Blackwell Science.
2. Clark, C.W : Bioeconomic Modelling and Fisheries Management
3. Hallan, T.G. and Levin, S.A. : Mathematical Ecology, Springer
4. Kapur, J.N : Mathematical Models in Biology and Medicine, Affiliated East-West Press
5. Pielou, E.C : Mathematical Ecology, John Wiley & Sons Inc.
6. Clark, C.W. : Mathematical Bioeconomics--the Optimal Management of Renewable Resources, Wiley-Inter Science.
7. Seber, G.A.F. : The Estimation of Animal,Abundance; The Blackburn Press.

M.Sc. Statistics Semester – III

Paper-V **Practical (Computer based)**

Max Marks : 80+20***
****Practical : 60**
Class Record: 10
Viva-Vice : 10
*** Internal Assessment**
Time: 4 hrs.

Note: There will be 4 questions, candidates will be required to attempt any 3 questions.

List of Practicals based on C and C++:

1. Estimation of population mean, total, confidence limits and variance of estimator under simple random sampling.
2. Estimation of population total, population mean and variance of estimator under stratified random sampling.
3. Calculation of optimum, proportional allocation.
4. Comparison of stratified sampling with different types of allocation with unstratified simple random sampling.
5. Comparison of systematic sampling with simple random and stratified random sampling.
6. Estimation of proportions and percentages, Variance of the estimators.
7. Estimation of variance in double sampling for stratification.
8. Estimation of gain in precision due to stratification from the results of stratified sample.
9. Ratio estimator for mean and total of population, variance of the estimators.
10. Comparison of ratio estimator with mean per unit estimator under simple random sampling.
11. Comparison of separate and combined ratio estimators under stratified random sampling with mean per unit estimate or under random sampling.
12. Comparison of different types of allocation for ratio estimator under stratified random sampling.
13. Comparison of two ratios.
14. Comparison of regression, ratio and mean per unit estimates from a simple random sample.

M.Sc. Statistics Semester - IV

Paper –I **Multivariate Analysis** **Max Marks: 80+20***

***Internal Assessment**

Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Notion of multivariate distribution, multivariate normal distribution of linear combination of normal variates, Marginal and Conditional distributions, Multiple and partial correlation coefficients. Characteristic function of a random vector, characteristic function when the random vector is normally distributed. Moments and semi-invariants of multivariate normal distribution. Estimation of the mean vector and covariance matrix, maximum likelihood estimator of the parameters of multivariate normal distribution.

Unit-II

The distribution of the sample mean vector and sample dispersion matrix. Sample correlation coefficient, maximum likelihood estimators of total, partial and multiple correlation coefficients; sampling distribution of simple, partial and multipal correlation coefficients when the corresponding population correlation coefficients are zero. Testing hypotheses of significance of these distributions.

Unit-III

Hotteling's T^2 and Mahalanobis D^2-Statistic; Justification , distribution and uses . The multivariate Behren's Fisher Problem and its solution. Classification Problem : Standards of good classification, Baye's and minimax regions for classification into one of two known multivariate normal populations when the parameters are known and unknown. Fisher's linear discriminator, Anderson's discriminator.

Unit-IV

Wishart Distribution : Definition, Character function and properties. Sample generalized variance, asymptotic distribution of sample generalized variances. Principal components in the population, Canonical correlation in the population.

References:

1. Anderson, T.W.(1983), : An Introduction to Multivariate Statistical analysis, Second Edition John Wiley.
2. Narayan, C. Giri : Multivariate Statistical analysis, Marcel Dekker.
3. Srivastava, M.S.& Khatri C.G.(1979), : An introduction to Multivariate Statistics, North Holland.
4. Kshirsagar, A.M.(1972) : Multivariate Analysis, Marcell-Dekher
5. Johnson, R.A & Wichern,D.W : Applied Multivariate Statistical Analysis,PHI Learning
6. Bhuyan, K.C : Multivariate Analysis and its applications, New Central Book Agency(P) Ltd.

M.Sc. Statistics Semester - IV

Paper – II **Linear Estimation & Design of Experiments** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four unit uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same

Unit –I

Linear estimation : Standard Gauss- Markov models, estimability of parameters, best linear unbiased estimators (BLUE) , Method of least squares and Gauss Markov theorem; Variance- covariance matrix of BLUES . Tests of Linear hypothesis, one-way and two way classifications Fixed, random and mixed effects Models (two - way classification)

Unit –II

Basic principles of experimental design. General block design and its information matrix, criteria of connectedness, balance and orthogonality. Construction and analysis of completely randomised, randomised blocks and Latin-square designs. Factorial experiments: Symmetrical factorials. Factorial experiments: 2^2-experiment, 2^3-experiment and 2^n-experiment in 2^k blocks per replicate.

Unit – III

Confounding, Fractional factorials, Split-plot design. Incomplete Block Design. Balanced incomplete block design, construction and analysis with and without recovery of intrablock information.

Unit – IV

Partially balanced incomplete block design: Construction and analysis with and without recovery of intrablock information. Optimality of design. Orthogonal Latin squares.

References:

1. Kshirsagar, A.M.(1972) : Linear Models, Marcell-Dekhar
2. Searle, S.R.(1971) : Linear Models , John Wiley & sons New York.
3. Aloke Dey, : Theory of Block Designs , Wiley Eastern Ltd. (Chapter First)
4. Chakrabarti, M.C.(1962) : Mathematics of Design and Analysis of Experiments, Asia Publishing House,(First Chapter.)
5. Joshi, D.D (1990) : Linear Estimation and Design of Experiments , Wiley Eastern Ltd. (Chapter Fourth)
6. Angela Dean and Daniel Voss (1999) : Design and Analysis of Experiments, Springer.

7. Das, M.N.and Giri, N (1979) : Design and Analysis of Experiments, Wiley Eastern.
8. Giri, N.(1986) : Analysis of Variance, South Asian Publishers.
9. John, P.W.M.(1971) : Statistical Design and Analysis of Experiments, Machmillan.
10. Montogomery, C.D.(1976) : Design and Analysis of Expertiments, Wiley, New York.
11. Meyers, R.H.(1971) : Response Surface Methodology, Allyn & Bacon.
12. Pearce, S.C.(1984) : Design of Experiments, Wiley, New York.
13. Rao, C.R.and Kleffe, J (1988) : Estimation of Variance Components and applications, North Holland.
14. Searle, S.R.,Casella, G. and McCulloch, C.E.(1992): : Variance Components, Willey.

M.Sc. Statistics Semester - IV

Paper-III & IVth Opt. (i) **Reliability and Renewal Theory** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same

Unit-I

Concept of reliability , early age failures, wearout failures and chance failures. Derivation of general reliability function failure rate, failure density function and mean time between failures (MTBF). System reliability evaluation: series system, parallel system, partially redundant system, standby system with perfect switching / imperfect switching. Effect of spare components (identical / non- identical) on the system reliability.

Unit-II

Wearout and Component reliability, Combined effect of wearout and chance failures.Reliability of a two component system with single repair facility. Reliability evaluation Techniques : Conditional probability approach , cut set method, approximation evaluation, Deducing the minimal cut sets. Tie set method , connection matrix technique.

Unit-III

General Introduction. The distribution of the number of renewals: The asymptotic distribution of N. The asymptotic normality of N_t with mean t/μ and variance $t/\mu 3$ The number of renewals in a random time, the renewal function , the asymptotic form of the renewal function. The renewal density, variance of the number of renewals.

Unit-IV

Backward and forward recurrence times. Limiting distribution of recurrence times. Pooled output of p renewal processes when p is small and its general properties. The mean time upto r^{th} renewal. The interval between successive renewals, study of the pooled output of p renewal processes when p is large. Alternating renewal processes: The renewal functions, the type of component in use at time *t*, equilibrium alternating renewal processes.

References:

1. Cox D.R. & Miller H.D. : Theory of Stochastic Processes, Chapman and Hall Ltd.
2. Billinton, R. : Reliability Evaluation of Engineering systems
   : Concepts and Techniques Plemum Press New York London.
3. Cox, D.R. : Renewal Theory, Methuen & Co. Ltd.
4. Medhi,J. : Stochastic Processes New Age International (P) Limited.
5. Igor Bazovsky : Reliability Theory and Practice, 2nd ed. Prentice Hall.

M.Sc. Statistics Semester - IV

Paper –III & IV Opt. (ii) Non –Linear and Dynamic Programming **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four unit uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same

Unit – I

Introduction:Classical optimization methods, maxima and minima in the absence of constraints, constrained maxima and minima, treatment of non-negative variables and inequality constraints. Convex and concave functions and their maxima and minima.Khun-Tucker theory : Necessary and sufficient conditions for saddle points, the Khun-Tucker theorem, Khun-Tucker's derivation of the necessary conditions.

Unit – II

Quadratic programming- Wolfe's approach for treating the quadratic objective function, Beale's Technique, Duality in quadratic programming. Separable programming and its reduction to LPP. Separable programming Algorithm, Fractional programming and computational procedure of fractional Algorithm.

Unit – III

Integer linear programming, Formulation of sequencing problems as integer linear programming problems, project planning and man-power scheduling, the traveling sales man problem , Capital budgeting in a firm. Solution of integer programming problems, Gomory's algorithm for all integer programming problems, Branch and Bound Algorithm.

Unit – IV

Dynamic Programming: Principle of optimality , Cargo Loading problem, Inventory Problem, Computational Technique , Dimensionality Problem , Approximation by piecewise linear functions, Optimal path Problem, Sequencing Problem, Control Problem, Optimal page allocation Problem , Serial Multi Stage system , Comparison of Linear & Dynamic Programming.

References:

1. Hadley, G. : Non linear and Dynamic programming.
2. Vejda,S. : Mathematical Programming, Dover Publications.
3. Kambo, N. S. : Mathematical Programming Techniques, East-West Press Ltd.
4. Mittal, K.V. : Optimization Methods, New Age International Pvt. Ltd.Publisher.

M.Sc. Statistics Semester - IV

Paper –III & IV Opt. (iii) **Information theory**

Max Marks: 80+20*
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same

Unit-I

Introduction : communication process, communication system, measure of information, unit of information. Memoryless finite scheme: Measure of uncertainty and its properties, sources and binary sources. Measure of information for two dimensional discrete finite probability scheme: conditional entropies, Noise characteristics of a channel, Relations among different entropies

Unit-II

Measure of Mutual information, Shanan's fundamental inequalities, Redundancy, Efficiency and channel capacity, capacity of channel with symmetric noise structures, BSC and BEC, capacity of binary channels, Binary pulse width communication channel, Uniqueness of entropy function

Unit-III

Elements of enconding : separable binary codes, Shannon-Fano encoding, Necessary and sufficient conditions for noiseless coding. Theorem .of decodibility, Average length .of encoded messages; Shannon's Binary Encoding.

Unit-IV

Fundamental theorem. of discrete noiseless encoding, Huffman's minimum redundancy code, Gilbert-Moore encoding. Error detecting and Error correcting codes, Geometry of binary codes, Hammings single error correcting code

References:

1. Reza, F.M. : An Introduction to Information Theory, Mc Graw Hill Book:Company Inc.
2. Feinstein, A. (I) : Foundations of Information Theory, McGraw Hill Book Company Ioc.
3. Kullback, S. (I) : Information Theory and Statistic., John Wiley and Sons.
4. Middleton, D. : An Introduction to Statistical Communication Theory, Mc Graw Hill Company.

M.Sc. Statistics Semester - IV

Paper –III & IV Opt. (iv) **Game Theory** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same

Unit-I

Rectangu1ar games, rectangular games with saddle points. Fundamental theorem of rectangular games: Mixed strategies, Geometrical background, Proof of the fundamental theorem for arbitrary rectangular games.

Unit-II

Properties of optimal strategies. Relations of dominance.A graphical method of solution. Applications of linear programming. The solution of a rectangular game . A method of approximating the value of a game.

Unit-III

Game in extensive form.Normal form and extensive form. Graphical representation information sets. Chance moves. Games with more than two players. Re3trictions on information sets. General theory of games in extensive form.

Unit-IV

General definition of finite games with perfect information equilibrium points. Games with perfect recall and behaviour strategies. Games with infinitely many strategies. The fundamental theorem for continuous games.

References:

Mackinsey, J.G.C. : Introduction to the theory of games McGraw Hill Book Company. Inc.. New Delhi, Toronto and London.

M.Sc. Statistics Semester - IV

Paper –III & IV Opt. (v) **Econometrics** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four units uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

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Unit-I

Aitken's generalized least square (G.L.S) estimator, Heteroscedasticity, auto-correlation, test of auto-correlation. Multicollinearity, tools for handling multicollinearity, .idea of ridge regression and properties of ridge regression. Lagged variables end distributed lag models : Meaning. Avarage lag, Koyak lag model, Alen lag model, partial adjustment model, Adaptive expectation model.

Unit-II

Simultaneous equation system : structure and models, typology of economic relations, structural form, reduced form and final form of an economic ,model. Problem of identification under linear homogeneous and Covariance restrictions. Rank and Order conditions of Identification, Restrictions on structural parameters.

Unit-III

Methods of estimation: Limited information models, indirect least squares. Two stage least squares, limited information maximum likelihood (LIML), fuIl information methods. Three stage least square (3SLS) and full information maximum likelihood (FIML).

Unit-IV

Estimation of demand common functional forms for estimation demand, estimation of demand from household budget and market data. Aggregated "problem, pooling of time series and cross section data. Estimation of production and cost function. Estimation of cabb-Dauglas, SMAC and translog production function estimation of cost curves and cost functions.

References:

1. Johnston, J. : Economic Models, McGraw Hills
2. Jan Kmenta : Elements of Econometrics, University of Michigan Press
3. Intriligatore,M.D. : Economic models -techniques and applications, Prentice Hall
4. Maddala, G.S. : Econometrics, North Holland
5. Klein, L.R. : Applied Economics, Taylor and Francis
6. Koytsoyiannis,A. : Theory of Econometrics, Barnes and Noble Books

M.Sc. Statistics Semester - IV

Paper –III & IV Opt. (vi) **Acturial Statistics** **Max Marks: 80+20***
***Internal Assessment**
Time: 3 hrs.

Note: There will be nine questions in all. Question No.1 will be compulsory covering whole of the syllabus and comprising short answer type questions. Rest of the eight questions will be set from the four unit uniformly i.e. two from each unit. The candidate will be required to attempt five questions in all one from each unit and the compulsory one. The weightage of all the questions will be the same.

Unit-I

Concepts of mortality rates and other indices, construction of mortality table from graduated data, determination and use of the functions in mortality table, graph of force of mortality, laws of mortality, mortality funds, Sources and collection of data for the continuous mortality investigation.

Unit-II

Models of population dynamics: Lotka' theory. Relationship between the number of births and the number of women in the population. Population with unvarying age distribution. Nature of reserve, prospective and retrospective reserves, fractional premiums and fractional durations, modified reserves, (continuous reserves, surrender values and paid up policies, Industrial assurance; children's. deffered assurances, Joint life and last survivorship.

Unit-III

Pure endowments, Life Annuities; Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportion able annuities-due. Accumulations, Assurances, family income benefits, capital sums on retirement and death.

Unit-IV

Widows pensions, Sickness benefits, disability benefits. Orphan's benefits, Benefits dependent on marriage. Contingent probabilities, contingent assurances, reversionary annuities, multiple-decrement table, forces of decrement, construction of multiple decrement table.

References:

1. King, G. : Institute of acutries text book of part II second edu. Charles and Edwin Layton London.
2. Jordan, C.W. Jr : Life Contingencies, second edition, Chicago Society of Actuaries.
3. Neil1, A. (1977) : Life Contingencies, Heinemann, London
4. Donald DWA (1970) : Compound interest and annuities. Heinemann London

M.Sc. Statistics Semester – IV

Paper-V Practical (Calculator and SPSS/SYSTAT based)

Max Marks : 80+20***
****Practical : 60**
Class Record : 10
Viva-Vice : 10
*** Internal Assessment**
Time: 4 hrs.

Note: There will be 4 questions, candidates will be required to attempt any 3 questions.

List of Practicals:

1. Estimating parameters of multinormal distribution.
2. Calculation of multiple and partial correlation coefficients.
3. Estimating the parameters of conditional distribution.
4. Test based on total, partial and multiple correlations.
5. Test based on Hotelling - T^2 and Mahalanobis - D^2 Statistics.
6. Fisher's linear discriminate function.
7. Calculation of principal components.
8. Analysis of three basic designs- Basic analysis and splitting of treatment S. S. for different contrasts.
9. Analysis of 2^2 – factorial experiment.
10. Analysis of 2^3 – factorial experiment.
11. Analysis of completely confounded factorial experiment.
12. Analysis of partially confounded factorial experiment.
13. Analysis of split plot design.
14. Analysis of BIB Design.
15. Analysis of P.B.I.B. Design.