UNIVERSITY OF JAMMU, JAMMU

(NAAC ACCREDITED 'A+' GRADE UNIVERSITY)

NOTIFICATION
(18/Oct./Adp/66)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the revised Syllabi and Courses of Study in the subject of **Statistics** of **Master Degree Programme** for I to IV Semesters under the **Choice Based Credit System (through regular mode)** in the main campus for the examinations to be held in the years as per the details given below: -

Subject	Semester	for the examination to be held in the years
Statistics	Semester-I	December 2018, 2019 and 2020
	Semester-II	May 2019, 2020 and 2021
	Semester-III	December 2019, 2020 and 2021
	Semester-IV	May 2020, 2021 and 2022

The Syllabi of the courses is available on the University website: www.jammuuniversity.in

Sd/-
DEAN ACADEMIC AFFAIRS

No. F. Acd/II/18/10037-10044
Dated: 03-10-2018

Copy for information and necessary action to:

1. Dean, Faculty of Mathematical Science
2. HOD/Convener, Board of Studies in Statistics
3. C.A to the Controller of Examinations
4. I/c Director, Computer Centre, University of Jammu
5. Asst. Registrar (Conf. /Exams. PG/Pub.)
6. Incharge, University Website for necessary action please.

Assistant Registrar (Academic)

3/10/2018

ANNEXURE-A

UNIVERSITY OF JAMMU
COURSE STRUCTURE FOR MASTERS DEGREE PROGRAMME IN STATISTICS

The Courses of Study prescribedfor 1st to 4th Semesters/Master's Degree Programme under CBCS in the Subject of **Statistics (Session 2018-19)**onwards

Semester	Course Code	Course Title	Credits	Nature of Course
I	PSSSTC101	Distribution Theory	4	CORE
	PSSSTC102	Sample Surveys	4	CORE
	PSSSPC103	Software Lab (MATLAB)	4	CORE
	PSSSPC104	Practical (based on PSSSTC 102)	4	CORE
	Any two of the following elective courses			
	PSSSTE105	Real Analysis	4	ELECTIVE
	PSSSTE106	Linear Algebra	4	ELECTIVE
	PSSSTE107	Information Theory	4	ELECTIVE
	PSSSTE108	Biostatistics	4	ELECTIVE
II	PSSSTC201	Probability Theory	4	CORE
	PSSSTC202	Design and Analysis of Experiment	4	CORE
	PSSSTC203	Inference-I	4	CORE
	PSSSTC204	Multivariate Analysis	4	CORE
	PSSSPC205	Software Lab (SPSS)	4	CORE
	PSSSPC206	Practical (Based on PSSSTC 202 and PSSSTC 204)	4	CORE
III	PSSSTC301	Inference-2	4	CORE
	PSSSTC302	C++	4	CORE
	PSSSPC303	Practical (Based on C++)	4	CORE
	PSSSPC304	Software Lab (Advanced SPSS)	4	CORE
	PSSSTO305	*Applied Statistical Methods -1	4	OPEN
	Students will study one open course from other departments		4	OPEN
	Any one of the following elective courses			
	PSSSTE306	Linear Models and Regression Analysis	4	ELECTIVE
	PSSSTE307	Non-parametric Methods	4	ELECTIVE
	PSSSTE308	Demography	4	ELECTIVE
IV	PSSSTC401	Stochastic Processes	4	CORE
	PSSSTC402	Optimization Techniques	4	CORE
	PSSSPC403	Software Lab (R Software)	4	CORE
	PSSSPC404	Practical (Based on one Elective course)	4	CORE
	PSSSTO405	*Applied Statistical Methods-2	4	OPEN
	Students will study one open course from other departments		4	OPEN
	Any one of the following elective courses			
	PSSSTE406	Econometrics and Time Series	4	ELECTIVE
	PSSSTE407	Operations Research	4	ELECTIVE
	PSSSTE408	Actuarial Statistics	4	ELECTIVE
	PSSSTE409	Statistical Computing	4	ELECTIVE
Total Credits earned by the students			96	

*For students of other Departments

Head
Department of Statistics
University of Jammu,

SCHEME OF EXAMINATIONS

Each paper shall carry 100 marks and distribution of marks in each theory and practical paper shall be as under:

Component	Marks	Remarks
Minor I	20	After 30 days on completion of 25 % of syllabus
Minor II	20	After 60 days on completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus, not covered in 2 Minors)
Total	100	

NOTE FOR PAPER SETTING:

Minor Examinations:

Question paper will have two sections A and B.Section-A will consist of six questions (Short answer type) of two marks each and candidate has to attempt five questions. Section B will consist of three questions (Long answer type) of five marks each and candidate has to attempt two questions.

Major Examinations:

Question paper will have two sections A and B. From Section-A will consist of five questions of three marks each, candidate will have to attempt four questions out of five given questions. Questions in this section will be framed from the fifty percent syllabus already covered in Minor I and Minor II. Section- B will consist of six questions of 12 marks each, three questions from each of the Unit III and IV (not covered in minors) and candidate will have to attempt four questions selecting two questions from each unit.

Head
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University of Jammu,
Jammu

SCHEME OF EXAMINATIONS

Internal Practical Examination:

Internal practical examination shall carry 50 marks. There shall be three theory questions each consisting of 08 marks and candidates has to attempt 2 questions. Internal shall be conducted after completion of 50% of the syllabi. The distribution of marks shall be as under.

Attendance (10 marks)	Viva voce (12 marks)	Day to Day performance (12marks)	Written Examination (16 marks)

External Practical Examination:

External practical examination shall carry 50 marks. There shall be three theory questions each consisting of 20 marks and candidates has to attempt 2 questions. Internal shall be conducted after completion of 100% of the syllabi. The distribution of marks shall be as under.

Written Examination(40 marks)	Viva voce (10 marks)

Head
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University of Jammu,
Jammu

Distribution of Courses and Credits
M.Sc Statistics (CBCS)

Semester – I

Course Code	Paper	Credits	Contact Hours per weekL-Tu-P
PSSSTC101	**Distribution Theory**	4	4-1-0
PSSSTC102	**Sample Surveys**	4	4-1-0
PSSSPC103	**Software Lab (MATLAB)**	4	4-1-0
PSSSPC104	**Practical (based on PSSSTC 102)**	4	4-1-0
PSSSTE105	**Real Analysis**	4	0-0-4
PSSSTE106	**Linear Algebra**	4	0-0-4
PSSSTE107	**Information Theory**	4	4-1-0
PSSSTE108	**Biostatistics**	4	
Total		**24**	**16-4-8**

Semester – II

Course Code	Paper	Credits	Contact Hours/ weekL-Tu-P
PSSSTC201	**Probability Theory**	4	4-1-0
PSSSTC202	**Design and Analysis of Experiment**	4	4-1-0
PSSSTC203	**Inference-I**	4	4-1-0
PSSSTC204	**Multivariate Analysis**	4	4-1-0
PSSSPC205	**Software Lab (SPSS)**	4	0-0-4
PSSSPC206	**Practical (Based on PSSSTC 202 and PSSSTC 204)**	4	0-0-4
Total		**24**	**16-4-8**

Semester – III

Course Code	Paper	Credits	Contact Hoursper weekL-Tu-P
PSSSTC301	**Inference-2**	4	4-1-0
PSSSTC302	**C++**	4	4-1-0
PSSSPC303	**Practical (Based on C++)**	4	4-1-0
PSSSPC304	**Software Lab (Advanced SPSS)**	4	4-1-0
PSSSTO305	***Applied Statistical Methods -1**	4	0-0-4
PSSSTE306	**Linear Models and Regression Analysis**	4	0-0-4
PSSSTE307	**Non-parametric Methods**	4	4-1-0
PSSSTE308	**Demography**	4	4-1-0
Total		**24**	**16-4-8**

Semester – IV

Course Code	Paper	Credit s	Contact Hours/ week L-Tu-P
PSSSTC401	**Stochastic Processes**	4	4-1-0
PSSSTC402	**Optimization Techniques**	4	4-1-0
PSSSPC403	**Software Lab (R Software)**	4	4-1-0
PSSSPC404	**Practical (Based on one Elective course)**	4	4-1-0
PSSSTO405	***Applied Statistical Methods-2**	4	0-0-4
PSSSTE406	**Econometrics and Time Series**	4	0-0-4
PSSSTE407	**Operations Research**	4	4-1-0
PSSSTE408	**Actuarial Statistics**	4	4-1-0
PSSSTE409	**Statistical Computing**	4	4-1-0
Total		**24**	**16-4-8**

L ï Number of Lecture, Tu ï Number of Tutorials, P ï Number of Practical hours.
*Optional only for other department students.

NOTE:The students of Statistics Department in III and IV semesters shall register for a minimum of 4 credits of courses from other Departments

SCHEME OF EXAMINATIONS

Each paper shall carry 100 marks and distribution of marks in each theory and practical paper shall be as under:

Component	Marks	Remarks
Minor I	20	On completion of 25 % of syllabus
Minor II	20	On completion of 50 % of syllabus
Major End Semester	60	On completion of syllabus (Question Paper Would Cover 20% of syllabus covered in Minor I and Minor II and 80% of syllabus, not covered in 2 Minors)
Total	100	

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No. PSSSTC101 **Title : Distribution Theory**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The objectives of this course are to make the students familiar with Distribution Theory.

Unit-I

Review of random variable and basic distribution theory. Joint, marginal and conditional p.m.fs. and p.d.fs, Functions of random variable and their distribution using Jacobean transformation and other tools, Standard discrete distributions viz., Binomial, Poisson, Rectangular, Negative binomial, Hyper Geometric.

Unit II

Standard continuous distributions viz., Normal, Uniform, Cauchy, Beta, Gamma, Log normal, Exponential, Bivariate normal, Bivariate Exponential (Laplace); Order statistics and their distribution, Joint and marginal distributions of order statistics, Distribution of median and range

Unit III

Introduction to special distributions: Degenerate, Two-point, negative Hypergeometric, Multinomial, Pareto, Logistic, Weibul and Rayleigh distributions. Conditional expectations, Simple, partial and multiple correlations, linear and multiple regression.

Unit IV

Compound, truncated and mixture distributions, Sampling distributions, Central and Non-central Chi-square, t-and F- distributions and their properties, Chebyshevs, Markov, Holder, Jensen and Lyapunov inequalities.

Books Recommended:

1. Fisz(1980) — Probability Theory and Mathematical Statistics, John Wiley & sons
2. Rohtagi, V,K & Ehsanes Saleh, A,K(2014) — An Introduction to Probability Theory and Mathematical Statistics, Wiley Series.
3. Kendall, M.G, Stuart, A(2001) — The Advanced theory of Statistics: Distribution Theory Vol 1, John Wiley & Sons
4. Johnson and Kotz(1995) — Continuous Univariate Distributions, vol 1 and vol 2, Wiley.
5. Rohtagi, V,K (1993) — An introduction of Probability Theory and Mathematical Statistics, Wiley.

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No.PSSSTC102 **Title : Sample Surveys**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The objectives of this course are to make the students familiar with various sampling methods.

Unit I

Estimation of sample size, Stratified random sampling, different methods of allocation, relative precision of stratified random sampling with S.R.S., formation and construction of strata, Post Stratification and Deep Stratification.

Unit-II

Systematic sampling, estimation of mean and sampling variance, comparison of systematic sampling with stratified and S.R.S., interpenetrating systematic sampling, Varying probability sampling methods of selecting sample with p.p.s, p.p.s, sampling W.R., efficiency of p.p.s. sampling. PPS WOR, H.T. estimator, Des Raj Sampling strategy, Murthy estimator, Sen-Midzuno method.

Unit-III

Ratio estimator, bias and mean square error, estimation of variance, comparison with SRS, ratio estimator in stratified sampling, unbiased type ratio estimators Difference estimator, regression estimator, comparison of regression estimator with SRS and ratio estimator, Cluster sampling with equal and unequal cluster sizes, relative efficiency with SRS and optimum cluster size.

Unit-IV

Two stage sampling with equal and unequal s.s.uôs, estimation of mean and sampling variance. Successive sampling, sampling on two occasions. Randomized response Technique.

Books Recommended:

1. W.G. Cochran (2013) Sampling techniques, Wiley & Sons
2. M.N. Murthy (1967) Sampling Theory and Methods, Statistical Publishing Society, Calcutta.
3. Des Raj (1999) Sampling Theory, Create Space Publishers, USA.
4. P. Mukhopadhayay (2014) : Theory and methods of survey sampling, PHI Learning.
5. D.Singh and F.S Chaudhary (2002): Theory and Analysis of sample Survey Designs, New age International Publications.
6. S Sampath (2005) : Sampling Theory & Methods, Alpha Science India Ltd.

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No.PSSSPC103 **Title : Software Lab(MATLAB)**
Credits:4

Objectives: To make students familiar with the compilation and Statistical analysis of data using Statistical Software MATLAB

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No.PSSSPC104 **Title : Practical bases on PSSSTC 102**
Credits:4

Objectives: To make students familiar with the computation work based on Course No. PSSSTC 102

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No. PSSSTE105 **Title : Real Analysis**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: This course introduces the students to concepts of Real Analysis.

Unit I

Introduction to Real number system, introduction to n-dimensional Euclidean space: Limit Points of a set, open sets, closed sets etc. (will be developed through general metric space and R^n will be considered as a special case, Compact sets, Bolzano-Weirsstrass theorem, Heine-Borel Theorem.

Unit II

Sequences and Series of real numbers, limit superior, limit inferior and limit of a sequence, their convergence, Cauchy sequence, Convergence of series, tests for convergence for series, absolute convergence, Cauchy products.

Unit III

Uniform convergence of sequences and series, Stone-Weirstrass theorem, power series, Fourier Series, Mean Value Theorem, Inverse function theorem, Implicit function theorem.

Unit IV

Improper integrals of first and second kind for one variable. Uniform convergence of improper integrals, differentiation under the sign of integral, Leibnitz rule, multiple integrals and their evaluation by repeated integration.

Books Recommended

1. Apostol, T.M (2002).: Mathematical Analysis, Narosa, Indian Edition.
2. Courant, R- and John F (1974): Introduction to calculus and Analysis, Wiley.
3. Miller, K.S (1957): Advanced Real calculus, Harper, New York.
4. Rudin, Walter (2013): Principles of Mathematical Analysis, McGraw.
5. Bartle, R.G (2007): Elements of Real Analysis (Wiley)

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No.PSSSTE106 **Title : Linear Algebra**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: This course introduces the students to concepts of Linear Algebra.

Unit I

Algebra of matrices, elementary matrices, linear transformations, row and column spaces of a matrix, rank and inverse of a matrix, null space and nullity, partitioned matrices, Kronecker product, fields, vector spaces, sub spaces, linear dependence and independence, basis and dimension of a vector space, finite, dimensional vector spaces, completion theorem, examples of vector spaces over real and complex fields.

Unit II

Vector spaces with an inner product, Gram-Schmidt Orthognalization process, Hermite canonical form, generalized inverse, Moore Penrose generalized inverse, left weak and right weak g-inverses, Idempotent matrices, solution of matrix equations. Gauss elimination method, triangulation method, Jacobin method and Gauss- Siedul iterative method.

Unit III

Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a positive definite matrix, characteristic roots and vectors, Cayley-Hamilton theorem, similar matrices, Hermitian quadratic forms.

Unit IV

Algebraic and geometric multiplicity of a characteristic root, spectral decomposition of a real symmetric matrices, reduction of a pair of real symmetric matrices, singular values and singular value decomposition, vector and matrix differentiation

Books Recommended:

1. Graybill, F.A (2001): Matrices with applications in Statistics, Cengage Learning.
2. Rao, C. R. (2002): Linear Statistical Inference and its Applications, John Wiley & Sons.
3. Searle, S.R. (1982): Matrix Algebra Useful for Statistics, John Wiley & Sons.
4. Bellman, R (1997).: Introduction to matrix Analysis, McGraw Hill.
5. Biswas, S. (2012): Topics in Algebra of matrices Academic publications.
6. Hadley, G. (2006): Linear Algebra, Narosa Publishing House.
7. Halmos, P.R. (1958): Finite Dimensional Vector Spaces, Springer.
8. K B Dutta (2014): Matrix and Linear Algebra, PHI Learning
9. De Franza, Daniel and Gagliardi (2012) Linear Algebra, Tata McGraw Hill

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year

Dec. 2018, 2019, 2020

Course No.PSSSTE107 **Title : Information Theory**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: To introduce information theoretic concepts.

Unit I

Concept of Entropy and information measures, Formal requirements of the average uncertainty, Shanonôs measure of information and its properties, Joint and Conditional Entropy, Relative entropy and mutual information, Uniqueness of the entropy function Jensen's Inequality and its consequences, Fano's Inequality, Asymptotic Equipartition Property, Entropy Rate.

Unit-II

Elements of encoding, redundancy and efficiency, binary codes ,Shanon Fano Encoding ,Necessary and sufficient condition for noiseless coding, Average length of encoded message Kraft Inequality, McMillan Inequality, Optimal Codes, Huffman Code, Fundamental theorem of discrete noiseless coding.

Unit-III

Differential Entropy, Joint and Conditional Differential Entropy, Properties of Differential and Relative Entropy, Differential Entropy of distribution, Relationship of Differential Entropy to Discrete Entropy, Differential entropy bound on discrete entropy Entropy Optimization Principles, Maximum Entropy Principle, MaxEnt Formalism, Maximum Entropy Distribution

Unit-IV

Channel capacity, symmetric channels, Binary symmetric channel, Binary Erasure channel, Properties of channel capacity. Joint AEP theorem, channel coding theorem (statement only), Fanoôs inequality and converse to the coding theorem, Hamming codes.

Books Recommended:

1.Shannon CE (1948) : The mathematical theory of communication. Bell Syst. Tech. J, Vol. 27, pp. 379-423 and pp 623-656.

2. VanderLubbe (1997): Information Theory, Cambridge University Press.

3. Thomas T. M. and Cover (2006): Elements of Information Theory. Wiley , New York.

4. Kapur,J.N. and Kesavan H.K (1992). : Entropy Optimization Principles with Applications, Academic Press, New York.

5. Reza, F.M. (2007): An Introduction to Information Theory, Dover

6. Robert Ash(1965) Publications. Information Theory .

Syllabus of Statistics M.A/M.Sc 1st Semester for the examination to be held in the year Dec. 2018, 2019, 2020

Course No.PSSSTE108 **Title : Bio-Statistics**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: This course introduces the students to various applications of statistics in biology and medical fields.

UNIT-I

Basic biological concepts in genetics, Mendelôs law, Hardy- Weinberg equilibrium, random mating, distribution of allele frequency (dominant/co-dominant cases), Approach to equilibrium for X-linked genes, natural selection, mutation, and genetic drift, equilibrium when both natural selection and mutation are operative.

UNIT-II

Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials. Sample size determination in fixed sample designs.

UNIT-III

Functions of survival time, survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shape hazard function. Tests of goodness of fit for survival distributions (WE test for exponential distribution, W-test for lognormal distribution, Chi-square test for uncensored observations).

UNIT-IV

Type I, Type II and progressive or random censoring with biological examples, Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples. Idea of Stochastic epidemic models: Simple epidemic models (by use of random variable technique).

Books recommended:

1. Biswas, S. (1995): Applied Stochastic Processes. A Biostatistical And Population Oriented Approach, Wiley Eastern Ltd.
2. Cox, D.R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall.
3. Elandt, R.C. and Johnson (1975): Probability Models and Statistical Methods in Genetics, John Wiley & Sons
4. Ewens, W. J. (1979): Mathematics of Population Genetics, Springer Verlag.
5. Ewens, and Grant, (2001): Statistical methods in Bio informatics.: An Introduction, Springer.
6. Friedman, L.M., Furburg, C. and DeMets, D.L (1998).: Fundamentals of Clinical Trials, Springer Verlag.
7. Gross, A. J. and Clark V.A. (1976): Survival Distribution; Reliability Applications in Biomedical Sciences, John Wiley & Sons.
8. Lee, Elisa, T. (1992): Statistical Methods for Survival Data Analysis, John Wiley & Sons.

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSTC201 **Title : Probability Theory**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: This course introduces the students to concepts of Probability and Measure Theory.

Unit I

Fields, sigma minimal sigma field, sigma-field generated by a class of subsets, Borel fields. Sequence of sets, limsup and liminf of sequence of sets, Measure, probability measure, properties of a measure, Continuity theorem of measure, Caratheodory extension theorem (statement only), Idea of Lebesgue and Lebesgue-Steiltjes measure, Signed measure, Jordan-Hahn decomposition theorem.

Unit II

Measurable functions, integration of a measurable function with respect to a measure, Monotone convergence theorem, Fatouôs lemma, dominated convergence theorem, Radon Nikodym Theorem, Product measure, Fubiniôs Theorem, Borel-Cantelli Lemma, Zero-One Laws of Borel and Kolmogorov.

Unit III

Convergence of a sequence of r.v.s, Almost sure convergence, convergence in probability, convergence in distribution, weak law and strong law of large numbers of sequences, Convergence of series of random variables, Three series criterion, Martingales.

Unit IV

Characteristic functions, and their simple properties, Parseval relation, Uniqueness theorem, Inversion theorem, Levyôs continuity theorem (statement only), CLT for lid random variables. CLT for a sequence of independent random variables under Lindebergôs condition, statements of Liapounov and Lindberg-Feller theorems.

Books Recommended

1. Ash, Robert (1972): Red Analysis and Probability, Academic Press.
2. Billinsley P. (1986): Probability and measure, Wiley.
3. Dudley, R.M. (2002): Real Analysis and Probability, Cambridge University Press
4. Kingman JFC and Taylor SJ (1966): Introduction to measure and probability. Cambridge University press.
5. B R Bhat (2014): Modern Probability Theory, New Age International Private Limited
6. Basu, A.K. (2012): Probability and Measure theory, Narosa Pub. House
7. Laha, R.G and Rohtagi: V K (1997) Probability theory, John Wiley
8. Rohtagi, V K and: Saleh A K (2014) Probability Theory, John Wiley
9. Chung, K L (2001): A Course in Probability Theory, Academic Press
10. Feller, W. (1998): Introduction to Probability and its Application Vol. II, Wiley Eastern Ltd.
11. Loeve, M. (1978): Probability theory, Springer Verlag.

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSTC202 **Title : Design and Analysis of Experiments**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives:Theaim of this course is to provide the knowledge of Design and Analysis of Experiments.

Unit I

Introduction to Design Experiments: General Block Design and its information matrix (c), Criteria for connectedness, balance and orthogonolity, intrablock analysis (estimability), best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypothesis), Fixed mixed and random effects models, variance components estimation, study of various methods.

Unit II

Missing plot techniques in RBD and LSD, Symmetrical Factorial experiments with factors at two and three levels (2^n, 3^2, 3^3), Confounding-Total and Partial in factorial experiments, Split plot Design.

Unit III

Incomplete and Balanced incomplete block designs, Lattice and Youden squares, partially balanced incomplete block design and its analysis.

Unit IV

Analysis of Covariance in RBD, LSD and CRD, Analysis of Covariance in Non-orthogonal Data in two way classification, Covariance and Analysis of experiments with missing observation.

Books Recommended:

1. D.D. Joshi(2003) : Linear Estimation and Design of Experiments.
2. O. Kempthorne(1994) Design and Analysis of Experiments.
3. Das and Giri(2003) Design and Analysis of Experiment.
4. Cochran and Cox(1992) Design of Experiments.
5. Aloke Dey (1986): Theory of Block Designs, Wiley Eastern.
6. Giri, M.N and Giri N(1979) Design and Analysis of Experiments, Wiley Eastern.
7. MontogomeryC.D(2013) Design and Analysis of Experiments, Wiley, New York
8. Searle, S.R. Casella G. and McCulloch, C.E (1992) Variance Components, Wiley.

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSTC203 **Title : Interfence-I**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives : The aim of this course is to provide the knowledge of Inference to the students.

Unit I

Introduction to estimation; unbiasedness, consistency, sufficiency and Minimal sufficiency, CAN estimators, Mean Square Error, Completeness and Bounded completeness, Factorization Criterion, Finite and asymptotic efficiency.

Unit II

UMVUE, Cramer-Rao inequality, Chapman-Robbins-Keifer lower bound, Rao-Blackwell Theorem, Lehmann Scheffe Theorem, Exponential and Pitman families Methods of Estimation: Maximum Likelihood method, methods of moments and percentiles.

Unit III

Testing of hypothesis; Basic concepts, randomized and nonrandomized test procedures, Neyman-Pearson Lemma, Families with MLR property, Examples of UMP unbiased tests for two sided hypothesis (Only for exponential families), Waldôs SPRT, Likelihood ratio test and its properties (without proof) and applications to normal distribution.

Unit IV

U- Statistics, its definition, properties as an estimator of its expectation, One-Sample and 2-Sample non parametric tests for Location (only standard test), Non parametric confidence intervals for percentiles, Interval estimation, confidence level, construction of confidence, intervals using pivots, shortest expected length confidence interval.

Books Recommended

1. Kale, B.K (2007): A first course a Parametric Inference, Narosa Publishing House.
2.Rohtagi, V. K. (1997): An introduction to probability and Mathematics Statistics, Wiley Eastern Ltd.
3.Fergusan T.S. (1967): Mathematical Statistics, Academic Press.
4.Zacks, S. (1971): Theory of Statistical Inference, John Wiley and sons, New York.
5.Lehman, E.L. (1998): Theory of Point Estimation, Springer.
6.Lehman, E.L. (1998): Testing Statistical Hypothesis, Springer.
7.Rao, C.R. (2003): Linear Statistical Inference, Wiley.
8. M Rajagopalan and B Dhanavanthan (2012): Statistical Inference PHI Learning Pvt. Ltd.

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSTC204 **Title : Multivariate Analysis**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The aim of this course is to provide the knowledge of Multivariate Analysis to the students.

Unit I

Multivariate normal distribution, Maximum likelihood estimates of mean vector and dispersion matrix, Distribution of sample mean vector, Wishart matrix-its distribution and properties, Null distribution of simple, partial and multiple correlation coefficients and their testing of significance.

Unit II

Hotellingôs T^2 statistic-its distribution and application in testing of mean vector for one and more multivariate normal populations, Mahalonobis D2 staistics and its application. Problem of classification, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Discrimination procedures for discriminating between two multivariate populations-sample discriminant function.

Unit III

Multivariate linear regression model-estimation of parameters, Distribution of sample regression coefficients, tests of linear hypothesis about regression coefficients, Multivariate Analysis of Variance (MANOVA) of one and two way classified data.

Unit IV

Principal Components Analysis, Factor Analysis Canonical variates and canonical correlations.

Books Recommended

1. Anderson, T.W(2003): An introduction to Multivariate Statistical Analysis, Wiley
2. Morrison, D.F(2003).: Multivariate Analysis, McGraw Hill
3. Johnson, R. and Wichern (2012) Applied Multivariate Statistical Analysis, PHI.
4. Jobson, D.B(1997).: Applied Multivariate Analysis, Springer

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSPC205 **Title : Software Lab(SPSS)**
Credits:4

Objective: To make students familiar with the computational work of SPSS softwarebased on the Descriptive and inductive statistics.

Syllabus of Statistics M.A/M.Sc 2nd Semester for the examination to be held in the year May 2019, 2020 and 2021

Course No.PSSSPC206 **Title : Practical based on PSSSTC 202**
and PSSSTC 204 **Credits:4**

Objective: To make students familiar with the computation work based on Course No. PSSSTC 202& PSSSTC 204.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No.PSSSTC301 **Title : Inference II**

Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives : To provide advanced knowledge of Inferential Statistics for decision making.

Unit I

Generalization of Neyman-Pearson Lemma (without proof), Unbiasedness in hypothesis testing, UMPU tests for two sided hypothesis ï in case of exponential families, similar tests and tests of Neyman structure and its relation to bounded completeness, UMPU test for multiparameter exponential families and its applications to Binomial and Poisson populations.

Unit II

Review of maximum likelihood estimation, MLE in Pitman family, MLE in censored and truncated distribution, Cramer family, Cramer-Huzurbazar theorem, solution of likelihood equation by method of scoring, Introduction to Sequential Estimation and Sequential Cramer ï Rao inequality.

Unit III

Consistency and relative efficiency in non-parametric set-up, Method of estimating ARE, U-Statistics, Mann-whitney U-test, Rank tests a) For location-Wilcxon two sample and Terry- Hoeffding, b) For dispersion- Mood test and Freund-Ansari Test. The K-Sample problem-Kruskal-wallis Test**,** General simple linear rank statistic, Tests for Goodness of fit, Tests of independence: chi-square Contingency Table, Kendallôs tau and Spearmanôs Rank correlation.

Unit IV

Statistical decision problem: non-randomized, and randomized decision rules, loss function, risk function, admissibility, Bayes rule, minimax rule, least favourable distribution, priori and posterior distributions, Admissible, Bayes and minimax estimators with illustrations.

Books Recommended:

1. Lehman, E.L. (1998): Theory of Point Estimation, Springer.
2. Lehman, E.L. (1998): Testing Statistical Hypothesis, Springe
3. Goon, Gupta, Das Gupta(2003): An outline of Statistical Theory, World Press Pvt.Ltd.
4. Rohtagi, V.K. (1998): An Introduction to Probability Theory and Mathematical Statistics., Wiley.
5. V.K. Rohtagi(1997): Statistical Inference, Wiley.
6. B.K. Kale(2007): Parametric Inference, Alpha science Int.Ltd.
7. S. Zacks: (1981) Theory of Statistical Inference, John Wiley.

8.T.S. Ferguson(1967) Mathematical Statistics: A Decision Theoretic Approach. John Wiley.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSTC 302 **Title : C++**

Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The aim of this course is to provide the knowledge of programing language C++ to the students.

Unit I

Flowchart, Algorithm and problem solving. General concepts of programming. C++ character set, C++ tokens (identifiers, keywords, constants, and operators), structure of C++ program, cout, cin, Use of I/O operators, Cascading of I/O operators. Data Types: Built-in data types- int , char, float, double, Integer constants, Character Constants, String Constants.Variable: Declaration of variable of built in data types. Operators: Arithmetic operators, Relational Operators. Logical operators. Increment and decrement operator. Conditional operator, Precedence of operators. Type Conversion: Automatic typeconversion, type casting. C++ short hands (--, ++, =), Assignment statement, variables initialization.

Unit II

Flow of control: Conditional statements, General form of if-else statement, if else if ladder, Nested if? As an alternative to if, General form of switch, Nested Switch. Simple control statement, for loop statement, while loop, do while loop. Variation in loop statements;Nested Loops, Loop termination: break, continue, go to, exit (), Single character input get char (), single character output (put char ()), gets and puts functions.Structured Data Type: Array, General form of Declaration and Use: one dimensional array, String two dimensional, Array initialization.

Unit III

Functions: General form, Function Prototype, definition of function, accessing a function. Passing arguments to function, Specifying argument Data type, Default argument, Constant argument, Call by value and Call by reference, returning value and their types, Calling function with arrays, Scope rules of function and variables, Local and Global variables, Storage class specifiers: extern, auto, register and static. Standard Header files ï string.h, math.h, stdlib.h , iostream.h. Standard library functions-string and char related functions: isalnum(), isalpha(), isdigit(), islower(), isupper(), tolower(), toupper(), strcpy(), strcat(), strlen(), strcmp (). Mathmatical functions: fabs(), frexp() ,fmod (), log(), log10(), pow(), sqrt(), cos(), abs().

Unit IV

Structures: specifying a structure, defining a structure variable, accessing structure members .Functions and structures, arrays of structures, arrays within a structure, Structure within structure Class: Specifying a class, public and private data members and member functions, defining objects , calling member function, constructor and destructor functions.

Books Recommended:

1. Robert Lafure(2002): C ++ Programming SAMS (USA)
2. Satish Jain(2003): Computer fundamentals and C++ Programming Vol. I, Ratna Sagar Pvt. Ltd., Delhi.
3. Al Stevens (1997): Teach Yourself C++, fifth Edition, Wiley Publications, New Delhi.
4. Ravichandran(2011): Programming in C++,McGraw Hill
5. Ankit Asthana (2007): Programming in C++.Narosa Publication

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSPC 303 **Title : Practical based on C++**

Credits:4

Objective: To make students familiar with the computation work, programming in C++ language and data analysis

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSPC 304 **Title Software Lab: Advanced SPSS**

Credits:4

Objective: To make students familiar with the computation work-based SPSS software and analysis and interpretation of data sets.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSTO 305 **Title : Applied Statistical Methods-I**
Credits:4 **Maximum Max. 100**

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Unit I

Concept of statistical population, Attributes and variables (discrete and Continuous). Different types of scales ï nominal, ordinal, ratio and interval. Primary data ï designing a questionnaire and schedule, collection of primary data, checking their consistency. Secondary data; scrutiny of data for internal consistency and detection of errors of recording. Ideas of cross validation. Presentation of data; classification, tabulation, diagrammatic & graphical representation of grouped data. Frequency distributions, cumulative frequency distributions and their graphical representations, histogram, frequency polygon , Ogives. Stem & Leaf Plot and Box Plot

Unit II

Measures of Central tendency and dispersion, merits and demerits of these measures. Moments and factorial moments. Skewness and Kurtosis and their measures. Measures based on Partition values.

Unit III

Bivariate data, Method of least squares for curve fitting. Correlation and regression, Their properties and interrelationship, rank correlation (Spearmanôs and Kendallôs measure). Intra-class correlation, Correlation ratio. Partial and Multiple Correlation & Multiple Regression for Trivariate data.

Unit IV

Testing of hypotheses :Statistical Hypotheses (null, alternative simple and composite)., Type I and Type II errors, significance level, p-values, power of a test. Point and confidence Interval Estimation. Standard error, Tests based on t, F and ¬2 distributions. Large sample tests .

Note: Emphasis would be on applied aspects of the course rather than theoretical derivations

Books Recommended:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2005): Fundamentals of Statistics, Vol. I, World Press, Kolkata.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, World Press, Kolkata.
3. Yule. & Kendall, (2000): An Introduction to the theory of statistics. Charles Griffin & Company Ltd.
4. Kapoor and Gupta (2007): Fundamentals of Mathematical Statistics, S Chand and Co.
5. Gupta, S.P. (2011): Statistical Methods.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSTE 306
Credits:4
Duration of examination 3 hours

Title : Linear Models & Regression Analysis
Maximum Max. 100

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The aim of this course to provide the knowledge of Linear Models and Regression analysis.

Unit I

Gauss-Markov set-up, Normal equations and Least squares estimates, Error and estimation spaces, variances and covariances of least squares estimates, estimation of error variance, estimation with correlated observations, least squares estimates with restriction on parameters.

Unit II

Simultaneous Estimates of linear Parametric functions, Tests of hypothesis for one and more than one linear parametric functions, confidence intervals and regions, Analysis of Variance, Power of F-test, Multiple comparison tests due to Tukey and Scheffe, simultaneous confidence intervals.

Unit III

Introduction to One-way random effects linear models and estimation of variance components, Simple linear Regression, multiple and polynomial regression, orthogonal polynomials.

Unit IV

Residuals and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers, Remedies, Introduction to non-linear models; least squares in non-linear case, estimating the parameters of a non linear system, reparameterization of the model, the geometry of linear and non linear least squares.

Books Recommended:

1 Cook, R.D. and Weisber, S. (1982): Residual and Influence in Regression, Chapman and Hall.

2.Draper, N.R. and Smith, H. (1998): Applied Regression Analysis 3rd Ed. Wiley.

3.Gunst, R.F. and Mason,R.L(1980): Regression Analysis and its Application- A Data Oriented Approach, Marcel and Dekker.

4.Rao, C.R. (2002): Linear Statistical Inference and its Applications, Wiley.

5.Weisber S. (1995): Applied Linear Regression, Wiley Eastern.

6.D.C. Montgomery and EA Peck (2012) : Introduction to Linear Regression Analysis, John Wiley &sons.

7. F. A Graybill (2000): Theory and Application of the Linear Models.Cengage Learning Models.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSTE 307 **Title : Non Parametric Inference**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: To make students familiar with non-parametric concepts related to inference.

Unit I

Distribution of F(x), Order Statistics and their distributions, Coverage probabilities and confidence intervals, empirical distribution function and its properties, asymptotic distributions of order-statistics, bounds on expected values.

Unit II

Single Sample problems, problem of location, Mathisen-Median test, Rosenbaum Statistics I and II, Linear rank statistics, Prediction intervals, Goodness of fit tests, Kolmogrov-Smirnov-one sample Statistic, sign test, Wilcoxon- Signed rank statistics, Walsh averages, general Linear rank statistics, Noetherôs Conditions, asymptotic distributions of above statistics.

Unit III

Two sample problems, Mann-Whitney-Wilcoxon test, Wilcoxon test, general linear rank statistic, Vander Warden Statistic, Scale problems-Statements and applications of Mood Statistic, freund-Ansari-Bradley-David-Barton statistics, Siegel-Tukey Statistic, Sukhatme test.

Unit IV

Efficiency of tests, asymptotic relative efficiencies Hoffdingôs, U-Statistics, Asymptotic distribution of U-Statistics, K-Sample problem, Kruskal-Wallis test, Kandallôs Tau coefficient and its sample estimate, Spearmanôs rank Correlation Coefficient.

Books Recommended:

1. D Gibbons (2011): Non-parametric Statistical Inference, Chapman and Hall.
2. DAS Fraser (1996): Non-parametric Methods in Statistics, Wiley
3.Rohatgi, V. K (1998).: An Introduction to Probability Theory & Mathematical Statistics John Wiley & sons
4.H.A. David (2003): Order Statistics John Wiley & sons
5.S.C. Gupta & Kapoor(2013) : Fundamentals of Mathematical Statistics, Sultan Chand New Delhi.

Syllabus of Statistics M.A/M.Sc 3rd Semester for the examination to be held in the year Dec. 2019, 2020 and 2021

Course No. PSSSTE 308 **Title : Demography Credits:4**
Maximum Max. 100

Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: To introduce application of Statistics in the field of Vital statistics Demography and Population studies.

UNIT-I
Vital statistics: Methods of collection, their merits and demerits, various fertility rates and their computations, factors affecting fertility rates, differential fertilities, graduation of fertility rates, Gross and net reproduction rates.

UNIT-II
Crude mortality rates, infant mortality rates standardized fertility and mortality rates. Life tables: its classification, properties and methods of action with special reference to King, Graville-Reed-Morrel and Chiang methods for construction of abridged life tables.

UNIT-III
Financial calculation, cause deleted tables and multiple detection, Sample variance of life table functions, Probability distribution of life table functions- Probability distribution of the number of survivors and observed expectation of life, joint probability distribution of the number of survivors and the number of distribution.

UNIT-IV
Makeham's and Gompertz curves, Population estimation and projection. Mathematical and component methods of projection. A brief account of other methods of population projection. Migration its concepts and estimation.

Books Recommended:

1. Spigelman(1968): Introduction to Demography, Harvard University Press
2. CoxP.R(1985) : Demography, Cambridge University Press
3. Keyfitz. N (2005): Applied Mathematical Demography Springer Verlag
4. Alho, Spencer, Bruce (2005): Statistical Demography and Forecasting, Springer-Verlag, New York

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTC401
Credits:4
Duration of examination 3 hours

Title : Stochastic Processes
Maximum Max. 100

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The aim of this course is to provide the knowledge of Stochastic Processes to the students.

Unit I

Introduction to stochastic processes (SPôs), Classification of SPôs according to state space and time domain, Countable state Markov Chains (MCôs), Chapman-Kolmogorov equations; calculation of n-step transition probability and its limit, Stationary distribution, Classification of states; transient MC, Random walk and gamblerôs ruin problem.

Unit-II

Discrete state space continuous time MCôs, Kolomogorav-Feller differential equations, Poisson Process, Birth and Death processes, Applications to queues and storage problems, Wiener process as a limit of random walk, first passage time and other problems.

Unit III

Renewal Theory; Elementary renewal theorem and applications, statement and uses of key renewal theorem, study of residual life time process, stationary process, weakly stationary and strongly stationary process.

Unit IV

Branching process, Galton-Watson branching process, probability of ultimate extinction, distribution of populations size, Martingale in discrete time, convergence and smoothing properties, Statistical inference in MC and Markov processes.

Books Recommended:

1Adke&Manjunath, (1984): An Introduction to Finite Markov processes,Wiley Eastern.
2.Bhat, B.R. (2004): Stochastic Models, Analysis and Applications, New Age International India.
3.Karline, S. and Taylor (1975): A First course in stochastic Process, Vol. I Academic Press.
4.Medhi, J. (2009): Stochastic Processes Wiley Eastern.
5.Parzen, E (1999): Stochastic Processes, SIAM
6. Ross, S M. (1996): Stochastic process John Wiley & sons
7. A.K. Basu(2007): Introduction to Stochastic Process, Alpha Science International, Ltd

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTC402
Credits:4
Duration of examination 3 hours

Title : Optimization Technique
Maximum Max. 100

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: The aim of this course is to make students acquaint with various Techniques of Optimization.

Unit I

Linear programming problem, formulation of LPP, Graphical method for solving LPPôs, Slack and surplus variables, FS, BS, BFS, Simplex method for solving LPP, two phase method (Artificial Variable Technique), Big-M-Method and degeneracy in LPP and its resolution.

Unit II

Duality in LPP, Correspondence between dual and primal, theorems on duality, Fundamental duality theorem, Basic duality theorem, existence theorem, Revised Simplex Method, Standard form for revised simplex method, formulation of LPP in standard form, Application of computation procedure for standard form, sensitivity analysis.

Unit III

Transportation problem (TP), formulation of TP, FS, BFS and optimum solution, existence of FS, optimal solution method, Methods for finding BFS, U-V (MODIôs) method for finding optimal solution, unbalance transportation problem, assignment problems, fundamental theorems of assignment problems, Hungarian method for assignment problems, Routing problems, Theory of games, rectangular games Minimax (Maximin) Criterion and optimal strategy, saddle point, optimal strategies and value of Game, sdution of saddle point, Minimax-Mximin principle missed strategy Games and their solutions through different methods including LPP, Minimax theorem.

Unit IV

CPM and PERT, Determination of critical pathôs different float times crashing, applications of CPM, PERT and Job sequencing, solutions of sequencing problems, processing n-jobôs through two-machines, Johnsonôs algorithm for n-jobsôs for 2- machines, processing 2-jobôs through n-machines graphical method, processing n-jobôs through m-machines.

Books Recommended:

1. H.A. Taha (2014) : Operations Research, Pearson Education India.
2. S.S. Rao (1984) : Optimization:Theory and applications, John Wiley.
3. Kanti Swarup and M.M. Gupta (2014) : Operations Research, Sultan Chand & Sons.
4. S.D. Sharma (2017) : Operations Research, Kedar Nath Ram Nath & Sons.
5. Harris and Gross (2008) : Fundamental of Queueing Theory, Wiley.

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSPC 403 Title : software Lab (Based on software R)
Credits:4

Objective: To make students acquaint with the software R and to do practicals using this software.

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSPC 404 Title : software Practical (Based on one elective course)
Credits:4

Objective: To make students familiar with the computation work based on chosen elective course.

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTO 405 **Title : Applied Statistical Methods –II**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Unit I

Sampling versus complete enumeration : sampling units and frame. Precision and efficiency of estimators. Simple Random sampling with and without replacement. Stratified random sampling. Problem of allocation, proportional allocation, optimum allocation. Systematic sampling, PPS sampling , estimation of population mean and population total, standard errors of these estimators. Use of random number tables in selection of random samples. Sample size determination.

Unit II

Analysis of Variance. One way classification. Assumptions regarding model. Two-way classification with equal number of observations per cell. Duncanôs multiple comparison test,Principles of Design of experiments: randomization, replication and local control. Randomized block design. Concept and definition of efficiency of design. Comparison of efficiency between CRD and RBD. Latin square Design : Lay-out, ANOVA table. Comparison of efficiencies between LSD and RBD; LSD and CRD. Factorial Experiments : Basic Concepts and examples.

Unit III

Non-parametric tests ï Tests for randomness and test for goodness of fit. One sample tests : sign test, Wilcoxon signed rank tests. Two sample tests : run test, Kolmogorov ï Smirnovôs test.Median test and Mann-Whitney U test. Mood tests and Sukhatme test for scale parameter,Spearmanôs rank correlation test, Kruskal Wallis and Friedman test.

Unit IV

Multivariate Data. Definition, Concept and applications of Multivariate analytical techniques: Multiple Linear Regression, MANOVA-One way, Factor Analysis, Discriminant and Classification Analysis, Case studies to understand applications of multivariate techniques.

Note: Emphasis would be on applied aspects of the course rather than theoretical derivations.

Books Recommended:

1. Gupta, S.C. and Kapoor, V.K. (2016): Fundamentals of Applied Statistics, Sultan Chand and Sons.

2. Miller, Irwin and Miller, Marylees (2014): John E. Freundôs Mathematical Statistics with Applications, Pearson Education, Asia.

3.Singh, D. and Chaudhary, F.S. (2002): Theory and Analysis of Sample Survey Designs. New Age International (P) Ltd.

4. Sukhatme and Sukhatme (1984): Sampling Theory of Surveys with Applications. Iowa State University Press, Iowa, USA.

5. Gibbons, J. D. and Chakraborty, S. (2011): Non-parametric Statistical Inference, Marcel Dekker, CRC.

6. Goon, A, Gupta, M and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8th Edn. World Press, Kolkata

7. Johnson and Wichern (2007): Applied Multivariate Analysis Statistical Analysis. PHI

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTE 406 **Title : Econometrics & Time Series**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60
d)

Objectives: The aim of this course is to provide the knowledge of Econometric methods to the students.

Unit I

A review of least squares and maximum likelihood methods of estimation of parameters in classical linear regression model and their properties (BLUE), Generalized Least Square Models, construction of confidence regions and tests of hypothesis, prediction, use of extraneous information in the form of exact and stochastic linear constraints, Restricted regression and mixed regression methods of estimation and their properties. Testing of extraneous information.

Unit II

Multicollinearity, its effects and deletion, Remedial methods including the ridge regression. Specification error analysis, inclusion of irrelevant variables and deletion of dominant variables, their effects on the efficiency of optimization procedure.

Unit III

Hetroscedasticity, consequences and tests for it, estimation procedures under heteroskedastic disturbances. Auto correlated disturbances, Effects on estimation of parameters, Cochran Orcutt and Prais-Winston transformation, Durbin-Watson test. Errors-in-variables model, Inconsistency of least squares procedures, Consistent estimation of Parameters by instrumental variables.

Unit IV

Seemingly unrelated regression equation model, Ordinary least squares and feasible generalized least squares methods and their asymptotic properties.Simultaneous equation model, problem of identification, A necessary and sufficient condition for the identifiability of Parameters in a structural equation, Ordinary Least squares, indirect least squares, two stage least squares and limited information maximum likelihood method, K-class estimators, Asymptotic properties of estimators.

Books Recommended:

1. Vinod, H.D. and A. Ullah(1981) : Recent Advances in Regression Methods,Marcel Dekkar
2. Jonsten, J.(1997) : Econometric Methods, McGraw Hill Book Company.
3. Srivastava, V.K. & D.E Giles(1987) Seemingly unrelated Regression Equations Models: Marcel Dekkar.
4. Maddala, G.S.(2006) : Econometrics McGraw Hill Koga Kusha Ltd.
5. Koutsoyiannis, A(2001) : Theory of Econometric, Macmillan
6. Theil, H.(1978) : Principles of Econometrics ,John Wiley
7. Gujarati, D.(2003) : Econometric Theory, McGraw Hill
8. Madanani (2008) : Introduction to Econometrics, Oxford and IBH Publishing House
9. Baltagi(2011) : Econometrics,SpringerVerlag

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTE 407 **Title : Operations Research**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: This course introduces the students to various optimization techniques of operations Research and some models of queuing theory.

Unit I

Inventory control, Introduction, Deterministic models, Economic lot size model with and without shortages, Probabilistic models, Single period model with uniform and continuous demand, models with price breaks, news papers boy problems.

Unit II

Introduction of queueing theory, concepts and various definitions, classification of queues and their problems, distribution of arrivals and service time, theorems based on arrival and departure times. Different queuing models M/M/1(FCFS, ∞, ∞), Probability distribution of different times and their expected values, Generalized M/M/1 Model, M/M/1 (FCFS, N) and M/M/C (∞, ∞, FCFS)

Unit III

Replacement Problems, Replacement of items that deteriorate, Replacement of items that fail completely, Recruitment and production problems, equipment renewal problems. Simulation, Types of Simulation, limitations of simulation, generation of random numbers and Monte-Carlo Simulation, Applications of Simulation to inventory control and Queuing problems.

Unit IV

Introduction to decision theory, Types of decision, Decision models, Types of Environment, EMV, EVPI, EOL. Decision making under uncertainly, Conflict and Decision Tree Analysis. Decision making under utilities: utility functions, curves and their construction. Posterior probabilities and Bayesian Analysis.

Books Recommended:

1. Ackoff. R.L. and M.W. Sasieni (1968) : Fundamentals of Operational Research, John Wiley
2. S. D. Sharma (2017) : Operations Research, Kedar Nath Ram Nath & Sons
3. Harris and Gross (2008) : Fundamental of Queueing Theory, Wiley.
4. H.A. Taha (2014) : Operations Research, Pearson Education India.
5. N.D.Vohra (2017) : Quantitative Techniques , TataMcGraw Hill.
6. N U Prabhu (1997) :Foundations of Queuing Theory, Springer

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTE 408 **Title : Actuarial Statistics**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objectives: To introduce and expose students to application of statistics in actuarial field.

Unit-I

Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curtate future lifetime, force of mortality.Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws.

Unit-II

Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations. Distribution of aggregate claims, compound Poisson distribution and its applications.

Unit-III

Principles of compound interest: Nominal and effective rates of interest and discount, force of interest and discount, compound interest, accumulation factor, continuous compounding.

Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions.

Unit-IV

Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.

Books Recommended:

1 Atkinson and Dickson (2011): An Introduction to Actuarial Studies, Edward Publishing.

2. Bedford, T. and Cooke, R. (2001): Probabilistic risk analysis, Cambridge University Press.

3. Bowers, Hickman and Nesbitt (1997): Actuarial Mathematics, Society of Actuaries, Ithaca, Illinois, U.S.A.

4. Medina, P. K. and Merino, S. (2003): A discrete introduction: Mathematical finance and Probability, Basel Publishers.

5. Neill, A (1977).: Life Contingencies, Butterworth- Heineman Ltd.

6. Philip, M. et. al (2004): Modern Actuarial Theory and Practice, Chapman and Hall.

7. Rolski,, Schmidt, & Teugels, (1998): Stochastic Processes for Insurance and Finance, Wiley.

8. Spurgeon, E.T. (2011): Life Contingencies, Cambridge University Press.

Syllabus of Statistics M.A/M.Sc 4th Semester for the examination to be held in the year May. 2020, 2021 and 2022

Course No. PSSSTE 409 **Title : Statistical Computing**
Credits:4 **Maximum Max. 100**
Duration of examination 3 hours

a) Minor test- I : 20
b) Minor Test- II :20
c) Major Test- :60

Objective: To introduce Statistical Computing.

Unit-I

Random numbers: Pseudo-Random number generation, tests. Generation of nonð uniform random deviatesï general methods, generation from specific distributions.

Unit-II

Simulation-Random Walk, Monte-Carlo integration, Applications. Simulating multivariate distributions; simulating stochastic processes.

Unit-III

Variance reduction. Stochastic differential equations: introduction. Numerical solutions. Markov Chain Monte Carlo methods-Gibbs sampling; Simulated annealing, cooling schedule, convergence, application.

Unit-IV

Non-linear regression: Method; Estimation; Intrinsic and Parameter-effects curvature; application. EM algorithm and applications. Smoothing with kernels: density estimation, choice of kernels.

Books Recommended:

1 Bishop, C.M. (1996): Neural Networks for pattern Recognition, Oxford University Press.
2. Duda,, Hart and Strok, (2007): Pattern Classification, , John Wiley & Sons.
3. Gentle, Härdle and Mori, (2004). Handbook of computational statistics ð Concepts and methods, Springer-Verlag.
4. Han, J. and Kamber, M. (2011). Data Mining: Concepts and Techniques, Morgan Kaufmann.
5. Hand, David, Heikki, & Smyth (2001): Principles of Data Mining, MIT Press.
6. Haykin, S. (1998): Neural Networks: A Comprehensive Foundation, 2nd Edition, Prentice Hall.
7. McLachlan & Krishnan, (2008): The EM Algorithms and Extensions, Wiley.
8. Nakhaeizadeh and Taylor (1996): Machine Learning and Statistics, John Wiley & Sons.
9. Pooch, Udo W. &Wall (1993): Discrete Event Simulation (A practical approach), CRC Press.
10. Rubinstein, R.Y. (2007): Simulation and the Monte Carlo Method, John Wiley & Sons.
11. Simonoff, J.S. (1996): Smoothing Methods in Statistics, Springer.