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UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC2(S)/151/2020-21 Dated: 01.09.2023

Notification

Sub:- Syllabus and Scheme of Examinations of Statistics (UG) (V & VI Semester) with effect from the Academic year 2023-24.

Ref:- 1. This office letter No: AC6/303/2022-23 dated: 28-07-2023.

2. Decision of BOS in Statistics (UG) meeting held on 28-08-2023.

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The Board of Studies in Statistics (UG) which met on 28-08-2023 has resolved to recommended and approved the syllabus and scheme of Examinations of Statistics programme (V & VI Semester) with effect from the Academic year 2023-24.

Pending approval of the Faculty of Science & Technology and Academic Council meetings the above said syllabus and scheme of examinations are hereby notified.

The syllabus and scheme of Examinations contents may be downloaded from the University website i.e., www.uni-mysore.ac.in.

Registrar
University of Mysore
Mysore

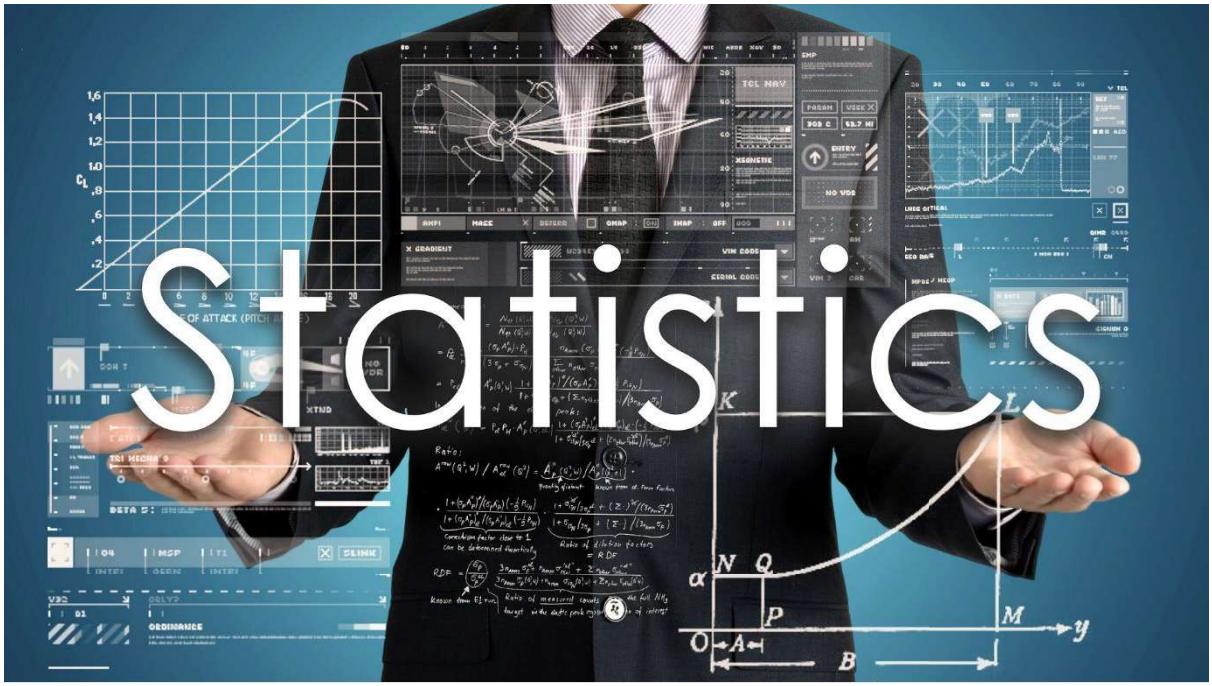
Registrar

To:-

1. All the Principal of affiliated Colleges of University of Mysore, Mysore.
2. The Registrar (Evaluation), University of Mysore, Mysuru.
3. The Chairman, BOS/DOS, in Statistics, Manasagangothri, Mysore.
4. The Director, Distance Education Programme, Moulya Bhavan, Manasagangotri, Mysuru.
5. The Director, PMEB, Manasagangothri, Mysore.
6. Director, College Development Council , Manasagangothri, Mysore.
7. The Deputy Registrar/Assistant Registrar/Superintendent, Administrative Branch and Examination Branch, University of Mysore, Mysuru.
8. The PA to Vice-Chancellor/ Registrar/ Registrar (Evaluation), University of Mysore, Mysuru.
9. Office Copy.

Government of Karnataka

Curriculum Framework for Undergraduate Programme in Colleges and Universities of Karnataka State



5th and 6th Semester Model Syllabus

for

BSc in

STATISTICS

Submitted to

Vice Chairman

Karnataka State Higher Education Council

30, Prasanna Kumar Block, Bengaluru City University Campus,

Bengaluru, Karnataka – 560009

Composition of Subject Expert Committee Members

SN	Name & Organization	Designation
1	Prof. Parameshwar V Pandit, Professor and Chairperson, Department of Statistics, Bangalore University, Bengaluru	Chairman
2	Dr. B S Biradar Professor and Chairperson, Department of Statistics, Mysore University, Mysuru	Member
3	Dr. Surekha B Munoli Professor, Department of Statistics Karnataka University, Dharwad	Member
4	Dr Sujata Inginshetty Professor and Chairperson, Department of Statistics Gulbarga University, Kalaburgi	Member
5	Dr Deepa Yogesh Kamat Associate Chairperson and Head, Department of Statistics Nrupathunga University, Bengaluru.	Member
6	Dr. R Vidya Professor, Department of Statistics Yuvaraja's College, Mysuru	Member
7	Dr. Savitha Kumari Department of Statistics SDM Degree College, Ujire, Dakshina Kannada.	Member
8	Sri Ravindra P Reddy Associate Professor, Govt. College, Sedam Road, Kalaburgi.	Member
9	Dr. S R Gani Department of Statistics Karnataka Arts College, Dharwad	Member
10	Dr. Tejaswini B Yakkundimath Special Officer Karnataka State Higher Education council	Member Convener

Model Curriculum

of

BSc

in

STATISTICS

5th & 6th Semester

Karnataka State Higher Education Council

Government of Karnataka

Model Curriculum

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Matrix algebra and regression analysis (Theory)**		
Course Code:	**STAC9-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Demonstrate and understanding of basic concepts of matrix algebra, including determinants, inverse and properties of various types of matrices.

CO2. Apply matrix algebra and linear algebra techniques to solve systems of linear equations, determine the rank of matrix, understanding quadratic forms and their applications in statistics, characteristic roots and vectors.

CO3. Develop and understanding of simple and multiple regression models, including the assumptions underlying these models, techniques for inference and hypothesis testing and diagnostics checks and corrections.

CO4. Apply regression analysis techniques to real world data sets.

Contents	**60 Hrs**
Unit 1: Algebra of matrices and determinants	15 Hrs
A review of matrix algebra, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary matrices. Adjoint and inverse of a matrix and related properties. Determinants ants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants. Jacobi's Theorem, product of determinants.	
Unit 2: Linear Algebra	15 Hrs
Linear algebra: Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations. inverse of a matrix. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices.	

Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, nature of quadratic form and properties. Linear orthogonal transformation and their digitalization.	
Unit 3: Simple linear regression	15 Hrs
Assumptions, inference related to regression parameters, standard error of prediction, tests on intercepts and slopes, extrapolation, diagnostic checks and correction: graphical techniques, tests for normality, uncorrelatedness, homoscedasticity, lack-of-fit testing, transformations on Y or X (Box-Cox, square root, log etc.), method of weighted least squares, inverse regression.	
Unit 4: Multiple linear regression	15 Hrs
Standard Gauss Markov setup, Gauss-Markov theorem (without proof), least squares (LS) estimation, variance-covariance of LS estimators, estimation of error variance, LS estimation with restriction on parameters. Simultaneous estimation of linear parametric functions. Tests of hypotheses for one and more than one linear parametric functions, confidence intervals, Variable selection problems.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Demonstrate and understanding of basic concepts of matrix algebra, including determinants, inverse and properties of various types of matrices.	x	x								x		
Apply matrix algebra and linear algebra techniques to solve systems of linear equations, determine the rank of matrix, understanding quadratic forms and their applications in statistics, characteristic roots and vectors.			x							x		
Develop and understanding of simple and multiple regression models, including the assumptions underlying these models, techniques for inference and hypothesis testing and method diagnostics checks and corrections.				x	x					x		
Apply regression analysis techniques to real word data sets				x	x							

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per University guidelines are compulsory	

Course Title	**Matrix algebra and Regression analysis (Practical)**	Practical Credits	**2**
Course Code	**STAC10-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Calculation of determinant of higher order
2. Calculation of rank of a matrix
3. Calculation of equivalent canonical form by using elementary row and column operations
4. Calculation of inverses of symmetric matrices of higher order by partitioning method
5. Calculation of inverse of matrices of higher order
6. Calculation of eigen values and eigen vectors
7. Solution of simultaneous equations
8. Simple Linear Regression
9. Multiple Regression-I
10. Multiple Regression -II .

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**

Formative Assessment as per UNIVERSITY guidelines are compulsory

References	
1	Ramachandra Rao, A. and Bhimasankaram, P. (2000). Linear Algebra.Hindustan Book Agency
2	Searle, S. R. (1982). Matrix Algebra Useful for Statistics, John Wiley, New York.
3	Kumaresan, S. (2000). Linear Algebra: A Geometric Approach, Prentice Hall

References	
4	Gilbert strang (2016) Linear Algebra and its Applications, 5th edition Cengage Learning.
5	Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003). Introduction to Linear Regression Analysis, Wiley.
6	Weisberg, S. (2005). Applied Liner Regression, Wiley.
7	Yan, X. and Su, X. G. (2009). Linear Regression Analysis: Theory & Computing, World Scientific.

Government of Karnataka

Model Curriculum

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Analysis of variance and Design of experiments (Theory)**		
Course Code:	**STAC11-T**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1. Learn fixed and random effect models and one-way and two-way classified data.

CO2.Understand different designs (CRD, RBD, LSD) and missing plot techniques.

CO3. Understand the different factorial experiments.

CO4. Develop complete and partial confounding for factorial experiments.

CONTENTS	**60 Hrs**
UNIT 1: ANALYSIS OF VARIANCE	15 Hrs
Meaning and assumptions. Fixed and random effect models. Analysis of One -way and two way classified data with and without interaction effects. Multiple comparison tests: Tukey's method, Critical difference.	
UNIT 2: EXPERIMENTAL DESIGNS	15 Hrs
Principles of design of experiments. Completely randomized, randomized block and Latin square designs (CRD, RBD, LSD) – layout formation and the analysis using fixed effect models. Comparison of efficiencies of CRD, RBD and LSD. Estimation of one and two missing observations in RBD and LSD and analysis.	

UNIT 3: FACTORIAL EXPERIMENT	15 Hrs
Basic concepts – main and interaction effects, and orthogonal contrasts in 2^2 and 2^3 factorial experiments. Yates' method of computing factorial effects total. Analysis of $2^2$and 2^3factorial experiments in RBD.	
UNIT 4: CONFOUNDING	15 Hrs
Need for confounding. Types of confounding - Complete and partial, Confounding in a 2^3 - factorial experiment in RBD and its analysis.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1.Learn about fixed, random, and mixed effect models and one-way and two-way classified data.	x	x		x		x			x	x		
CO2.Understand different designs (CRD, RBD, LSD) and missing plot techniques.	x	x				x			x	x		
CO3. Understand the different factorial experiments.	x	x				x			x	x		
CO4. Develop complete and partial confounding for factorial experiments.	x	x		x		x			x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

Course Title	**Analysis of variance and Design of experiments (Practicals)**	Practical Credits	**2**
Course Code	**STAC12-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. ANOVA for one-way classified data.
2. ANOVA for two-way classified data.
3. Analysis of CRD.
4. Analysis of RBD.
5. Analysis of LSD.
6. Missing plot techniques in RBD and LSD.
7. Analysis of 2^2 factorial experiment usingRBD layout.
8. Analysis of 2^3 factorial experiment using RBD layout.
9. Analysis of 2^3 factorial experiment using RBD layout (Complete confounding).
10. Analysis of 2^3 factorial experiment using RBD layout (Partial confounding).

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Goon, A. M., Gupta, M. K., Das Gupta, B.(1991). Fundamentals of Statistics, Vol-I, World Press, Calcutta.
2	Montgomery. D. C. (2014): Design and Analysis of Experiments, Wiley. New York.
3	Joshi. D. D. (1987): Linear Estimation and Design of Experiments, New Age International (P) Limited, New Delhi.
4	Cochran. G and G. M. Cox, G. M. (1992): Experimental Designs, John Wiley and Sons, New York.
5	Mukhopadhyay. P (2015): Applied Statistics, Books and Allied (P) Ltd., Kolkata.

Government of Karnataka

Model Curriculum

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Statistical Inference-II (Theory)**		
Course Code:	**STAC14-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand expected loss, decision rules, decision principles and Bayes and minimax decision rule.

CO2. Learn about UMP test, MLR property and Likelihood ratio tests.

CO3. Explore about sequential inference.

CO4. Learn about one sample and two sample nonparametric tests.

Contents	**60 Hrs**
Unit-1: Statistical Decision Theory	15 Hrs
Basic elements of Statistical Decision Problem. Expected loss, decision rules (nonrandomized and randomized), decision principles (conditional Bayes, frequentist), inference as decision problem, Loss function, squared error loss, Bayes and minimax decision rule.	
Unit-2: Testing of Hypothesis-II	15 Hrs
Definition of UMP test, monotone likelihood ratio (MLR) property, Examples of distributions having MLR property, Construction of UMP test using MLR property. UMP test for single parameter exponential family of distributions. Likelihood ratio (LR)tests, LR test for normal, exponential.	
Unit -3: Sequential Inference	15 Hrs
Need for sequential analysis, Wald's SPRT, ASN, OC Functions, examples based on Bernoulli, Poisson, Normal and exponential distributions.	
Unit-4: Nonparametric tests	15 Hrs
Nonparametric and distribution-free tests, one sample problems: Sign test, Wilcoxon signed rank test, Kolmogorov-Smirnov test. Test of randomness using run test.	

General two sample problems: Wolfowitz runs test, Kolmogorov Smirnov two sample test (for sample of equal size), Median test, Wilcoxon-Mann-Whitney U-test. Several sample problems: Friedman's test, Kruskal Wallis test	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1. Understand expected loss, decision rules, decision principles and Bayes and minimax decision rule.	x	x	x	x					x	x		
CO2. Learn about UMP test, MLR property and Likelihood ratio tests.	x	x	x	x					x	x		
CO3. Explore about sequential inference.	x	x	x	x					x	x		
CO4. Learn about one sample and two sample nonparametric tests.	x	x	x	x					x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

Course Title	**Statistical Inference-II (Practicals)**	Practical Credits	**2**
Course Code	**STAC15-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Problems on Bayes and minimax estimation.
2. UMP test based on sample from Bernoulli and Poisson distributions.
3. UMP test based on sample from Normal and exponential distributions.
4. Construction of SPRT for Bernoulli and Poisson distributions.
5. Construction of SPRT for Normal and Exponential distributions.
6. Evaluation of SPRT for Bernoulli and Poisson distributions using OC and ASN function.
7. Evaluation of SPRT for Normal and Exponential distributions using OC and ASN function.
8. One sample Nonparametric tests: Kolmogorov-Smirnov test, sign test, Wilcoxon signed rank test,
9. Two sample Nonparametric tests: Mann-Whitney (Wilcoxon rank sum test), Wald-Wolfowitz Run test,
10. Several sample Nonparametric tests: Kruskal -Wallis test, Friedman's test.

References

1	Berger, J.O.(1985): Statistical Decision Theory and Bayesian Analysis, 2nd Edition. Springer Verlag.
2	Bernando, J.M. and Smith, A.F.M.(1993): Bayesian Theory, John Wiley and Sons.
3	Robert, C.P.(2007): The Bayesian Choice: A Decision Theoretic Motivation, Springer.
4	George Casella, Roger L. Berger (2020): Statistical Inference, 2nd ed., Thomson Learning.
5	Rohatagi, V.K.: (2010): Statistical Inference, Wiley Eastern, New Delhi.
6	Hogg Mckean and Craig (2009): Introduction to Mathematical Statistics, 6th edition ,Pearson Prentice Hall.

Government of Karnataka

Model Curriculum

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	Sampling techniques and Statistics for national development **(Theory)**		
Course Code:	**STAC16-T**	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Understand the principles underlying sampling as a means of making inferences about a population.

CO2. Understand the difference between probability and nonprobability sampling.

CO3. Understand different sampling techniques.

CO4. To learn to estimate population parameters from a sample.

CO5. Understand official statistical system in India and their functions.

CO6. Understand the role statistics in national development.

Contents	**60 Hrs**
Unit 1: Introduction to sampling theory	15 Hrs
Objectives and principles of sampling theory; Concept of population and sample; complete enumeration versus sampling; Planning, execution and analysis of a sample survey; practical problems at each of these stages; basic principle of sample survey; sampling and non-sampling errors; Types of sampling: non-probability and probability sampling, pilot survey.	
Unit 2: Simple random sampling	15 Hrs
Simple random sampling with and without replacement, definition, and procedure of selecting a sample, estimates of population mean, total and proportion, variances and SE of these estimates, estimates of their variances related proofs, sample size determination.	

Unit 3: Stratified sampling and systematic sampling	15 Hrs
Stratification and its benefits; basis of stratification, Technique, estimates of population mean and total, variances of these estimates, proportional, optimum allocations, Neyman's allocation, allocation with cost functions and their comparison with SRS. Practical difficulties in allocation, derivation of the expressions for the standard errors of the above estimators when these allocations are used, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Linear systematic sampling Technique; estimates of population mean and total, variances of these estimates (N=n x k). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.	
Unit 4: National development	15 Hrs
An outline of present official statistical system in India, Role, function, and activities of Central and State Statistical organizations. Methods of collection of official statistics, their reliability and limitations. Central Statistical Office (CSO), National Sample Survey Office (NSO), Registrar General Office and National Statistical Commission. Scope and content of Population census of India. Population census methods, economic census. Methods of national income estimation, problems in the estimation of national income. System of collection of Agricultural Statistics. . Crop yield, Production Statistics, Crop estimation and forecasting. Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1.Understand the principles underlying sampling as a means of making inferences about a population.	x	x	x	x					x	x		
CO2.Understand the difference between probability and nonprobability sampling.	x	x	x	x					x	x		
CO3. Understand different sampling techniques.	x	x	x	x					x	x		
CO4. To learn to estimate population parameters from a sample.	x	x	x	x					x	x		
CO5. Understand official statistical system in India and their functions.	x	x	x	x					x	x		
CO6. Understand the role statistics in national development.	x	x	x	x					x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

Course Title	Sampling techniques and Statistics for national development **(Practical)**	Practical Credits	**2**
Course Code	**STAC17-P**	Contact Hours	**60 Hours**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Practical Content

1. Drawing of random sample under SRSWOR from a given population and estimation of the mean and total and the standard error of the estimator.
2. Drawing of random sample under SRSWR from a given population and estimation of the mean and total and the standard error of the estimator.
3. Construction of Confidence Intervals for mean and total for SRSWR and SRSWOR.
4. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR
5. Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWOR.
6. Estimation of the mean, total and the standard error of the estimator under stratified random sampling.
7. Exercise on allocation of samples in Stratified sampling. (Proportional Allocation)
8. Exercise on allocation of samples in Stratified sampling. (Neyman Allocation)
9. Systematic sampling
10. Estimation techniques in official statistics.

Pedagogy: Practical assignments 1 to 10 have to be first solved manually (using scientific calculators) and executed using R-programming.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Test 1	10
Internal Test 2	10
Attendance	5
Total	**25 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Cochran, W. G. (2007): Sampling Techniques, Third Edition, Wiley India Pvt. Ltd., New Delhi.
2	Changbao Wu and Mary E. Thompson (2020): Sampling Theory and Practice, Springer Nature Switzerland.

References	
3	Raghunath Arnab (2017): Survey Sampling Theory and applications (2017), Elsevier
4	Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
5	Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press
6	Murthy, M. N. (1967): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.
7	Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi
8	Mukhopadhyay, P. (1998): Theory and Methods of Survey Sampling. Prentice Hall
9	Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.
10	Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.
11	Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi.
12	Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi. http://mospi.nic.in/

Government of Karnataka

Model Curriculum: DSE

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Operations Research (Theory)**		
Course Code:	**STAE1-T (A)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Formulate a linear programming problem and solve it using graphical, simplex methods. conceptualize the feasible region and to find out feasible solution.

CO2. Solve transportation and assignment problems and give the optimal solution.

CO3. Solve game problems using different techniques.

CO4. Describe an inventory system, simple inventory models and obtain mathematical solutions.

CO5.Understand Need for replacement. Replacement policy for items which deteriorate with time. Group replacement policy

CO6.Understand a queueing system and its different components; derive the characteristics of a single server queue.

Contents	**45 Hrs**
Unit 1: Introduction to OR and LPP	15 Hrs
Definition and scope of operations research (OR). Linear programming problem (LPP): Definition, standard and canonical forms. Formulation of LPP. Basic feasible solutions, degenerate and non-degenerate solutions. Graphical solution and simplex algorithm for solving an LPP. Criteria for unbounded, multiple, and infeasible solutions. Big-M method.	
Unit 2: Transportation, assignment problems and game theory	15 Hrs
Mathematical formulation of transportation problem. Existence of feasible solution. Finding initial basic feasible solution: North - West corner rule and Vogel's method. Test for optimality. Transportation algorithm. Problem of degenerate solution. Unbalanced transportation problem.	

Mathematical formulation of assignment problem and Hungarian algorithm. Unbalanced assignment problems. **Game Theory**: Basic concepts of game theory. Two-person zero sum game. Pure and mixed strategies. Maximin–Minimax principles, Games with saddle point. Principle of dominance. Games without saddle point. Mixed strategies. Determination of optimum solution for a 2x2 game.	
Unit 3: Inventory, replacement and Queuing theory:	15 Hrs
Description of an inventory system. Inventory costs. Demand, lead time, and reorder level. Inventory models. EOQ model with and without shortages. Need for replacement. Replacement policy for items which deteriorate with time. Optimum policy with discrete and continuous time. Group replacement policy. **Queuing theory:** Characteristics of a queuing system. Steady state system size distribution in M/M/1 queuing system (only statement). Waiting time distributions. Little's formula, measures of effectiveness, derivation of expressions for expected queue length, and expected system size(length) and expected waiting times.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1. Formulate a linear programming problem and solve it using graphical, simplex methods, conceptualize the feasible region and to find out feasible solution.	x	x	x	x					x	x		
CO2. Solve transportation and assignment problems and give the optimal solution.	x	x	x	x					x	x		
CO3. Solve game problems using different techniques.	x	x	x	x					x	x		
CO4. Describe an inventory system, simple inventory models and obtain mathematical solutions.	x	x	x	x					x	x		
CO5.Understand Need for replacement. Replacement policy for items which deteriorate with time. Group replacement policy	x	x	x	x					x	x		
CO6.Understand a queueing system and its different components; derive the characteristics of a single server queue.	x	x	x	x					x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Churchman, C.W, Ackoff, R.L., and Arnoff, E.L. (1957). Introduction to Operations Research, John Wiley and Sons, New York.
2	Kanthi Swaroop, Manmohan, and P.K. Gupta (2012). Operations Research, Sultan Chand, New Delhi.
3	Kalavathy, S. (2004). Operations Research, Vikas Publishing House Pvt. Ltd. New Delhi.
4	Shenoy, G.V., Srivastava, U. K., and Sharma, S.C. (2009). Operations Research for Management, 2/e, New Age International, New Delhi.
5	Mustafi, C.K. (2006). Operations Research: Methods and Practice, 3/e, New Age International, New Delhi.
6	Mital, K.V. and Mohan, C. (2004). Optimization Methods, 3/e, New Age International, New Delhi.
7	Narag, A. S. (1970). Linear Programming and Decision Making, S. Chand, New Delhi.
8	Hillier, F.S. and Leiberman, G. J. (1962). Introduction to Operations Research, Holden Day, NewYork.
9	Taha, H.A. (2010). Operational Research: An Introduction, Macmillan, New York.

Model Curriculum: DSE

Program Name	**BSc in STATISTICS**	Semester	**V**
Course Title	**Demography and Vital statistics (Theory)**		
Course Code:	**STAE1-T (B)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. acquire knowledge about the size, composition, organization and distribution of the population.

CO2. perform basic demographic analysis using various techniques.

CO3. study the trend of population growth which describes the past evolution, present distribution and future changes in the population of an area.

CO4. acquire knowledge about the construction of life table and its applications in demographic analysis.

Contents	**45 Hrs**
Unit 1: Introduction and Sources of Demographic Data	15 Hrs
Demography**:** Its definition, nature, and scope. Sources of demographic data – salient features of Census, Civil Registration System, Demographic Surveys, their limitations and uses. Coverage and content errors. Vital Statistics: Introduction, definition, and uses of Vital statistics. Sources of data on Vital statistics. Measurement of population, rates, and ratios of vital events.	
Unit 2: Fertility and Population Growth	15 Hrs
Basic concepts and terms used in the study of fertility. Measures of fertility- Crude Birth Rate (CBR), General fertility rate (GFR), Age-Specific Fertility Rate (ASFR), Total Fertility Rate (TFR), use of Birth order statistics, Child Women ratio. Measures of reproduction- Gross Reproduction rate and Net Reproduction rate. Measurement of population growth rate- simple growth rate and compound growth rate. Pearl's Vital Index. Population Estimation, Projection and Forecasting: Use of A.P. and G.P. methods for population estimates, Fitting of Logistic curve for population forecasting using Rhode's method.	
Unit 3: Mortality and Life Tables	15 Hrs
Basic concepts and definitions of mortality. Measures of mortality- Crude Death Rate (CDR), Age Specific Death Rate(ASDR), Standardized death rates, Neonatal, Perinatal and Postnatal mortality rates, Maternal and Infant mortality rates. Cause Specific Death Rate.	

Life tables : Components of a life table, force of mortality and expectation of life table, types of life tables. Construction of life tables using Reed-Merrell's method , Greville's method. Uses of life tables.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1. acquire knowledge about the size, composition, organization and distribution of the population.	x	x	x	x					x	x		
CO2. perform basic demographic analysis using various techniques.	x	x	x	x					x	x		
CO3. study the trend of population growth which describes the past evolution, present distribution and future changes in the population of an area.	x	x	x	x					x	x		
CO4. acquire knowledge about the construction of life table and its applications in demographic analysis.	x	x	x	x					x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Bhende, Asha and Tara Kanitkar, (2004): Principles of Population Studies, 5th Ed. Himalaya Publishers, New Delhi.
2	Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
3	Keyfitz, N and Caswell. H (2005): Applied Mathematical Demography, Springer.
4	Mishra, B. D, (1981): An Introduction to the Study of Population, South Asian Publishers, Pvt. Ltd.
5	Ramakumar, R, (1986): Technical Demography, Wiley Eastern Ltd, New Delhi.
6	Pathak, K. B and F. Ram, (1998): Techniques of Demographic Analysis, Himalaya Publishing House, Mumbai.
7	Pressat, R, (1972): Demographic Analysis, Edward Arnold, London.
8	Shryock, H. S. et al (1979): The Methods & Materials of Demography, Condensed Edition by Stockwell, E. G, Academic Press, New York.
9	Srinivasan K. (1998): Basic Demographic Techniques & Applications, Sage Publications, New Delhi

Model Curriculum: DSE

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Statistical Quality Control (Theory)**		
Course Code:	**STAE2 (A)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1: Learn about process control and product control, different limits and causes of variation.

CO2: Understand control chart for variables and process capability.

CO3: Understand lot acceptance sampling and sampling plans.

Contents	**45 Hrs**
Unit 1: Introduction	15 Hrs
Introduction – Statistical Quality Control (SQC) - Aims and objectives, Chance and assignable causes of variation, Process control and product control. Control charts and basis for its construction, Action, and warning limits. Various tools of SQC.	
Unit 2: Process Control and Process Capability	15 Hrs
Control charts for variables: Derivation of control limits, basis, construction and interpretation of mean, range and standard deviation charts, np-chart, p-chart, stabilized p-chart c-chart and u-chart. Rational subgroups, Criteria for detecting lack of control. Process capability study: Natural tolerance limits and specification limits, process capability, PCR and interpretation.	
Unit 3: Acceptance Sampling (Product Control)	15 Hrs
Lot Acceptance Sampling – Sampling Inspection,100 % inspection and rectifying inspection AQL, LTPD, Producer's Risk and Consumer's Risk. Acceptance sampling plans – single and double sampling plans by attributes.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1: Learn about process control and product control, different limits and causes of variation.	x	x	x	x					x	x		
CO2: Understand control chart for variables and process capability.	x	x	x	x					x	x		
CO3: Understand lot acceptance sampling and sampling plans.	x	x	x	x					x	x		

Pedagogy:

1. The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Goon, A. M., Gupta, M. K., Das Gupta, B. (1991). Fundamentals Of Statistics, Vol. II (World Press, Calcutta).
2	Grant, E. L. and Leavenworth, R. S. (1996): Statistical Quality Control. 7th Edition, McGraw hill, New York.
3	Mahajan, M. (2001): Statistical Quality Control, Dhanpat Rai & Co. (P) Ltd. New Delhi.
4	Gupta, R. C: Statistical Quality Control (Khanna Pub, Co.)
5	Montgomery, D .C (2013): Introduction to Statistical Quality Control, (Wiley Int.Edn)
6	Gupta, R. C and V. K. Kapoor (): Fundamentals of Applied Statistics, (Sultan Chand and Co.)
7	Alwan, L. C. (2000). Statistical Process Analysis, McGraw Hill, New York.
8	John, S. Oakland and Follwell, R. F. (1990): Statistical Process Control. (East West Press, India)
9	Mukhopadhyay. P. (1996): Applied Statistics, Calcutta Publishing House.
10	Wetherill, G. B. and D. W.B (): Statistical Process Control Theory and Practice. (Chapman and Hall).

Program Name	**BSc in STATISTICS**	Semester	**VI**
Course Title	**Reliability Analysis (Theory)**		
Course Code:	**STAE2 (B)**	No. of Credits	**3**
Contact hours	**45 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Find reliabilities of various models of mechanical units (industry), biological science, health science, finance.

CO2.Understand impact of age on functioning of systems.

CO3. Know impact of configuration of sub-assemblies on performance

CO4. Evaluate and analyse reliabilities of models.

Contents	**45 Hrs**
Unit 1: Reliability	15 Hrs
Introduction to Reliability Theory, Definitions and interrelationships of reliability function, failure rate (hazard rate), cumulative failure rate, conditional reliability, residual life, mean residual life for both continuous and discrete distributions. Distributions useful in modeling the life length: Binomial, Poisson, Geometric, Exponential, Weibull, Gamma, Pareto, Normal, Truncated Normal and Log Normal (derivation of failure reliability functions).	
Unit 2: Notion of Ageing	15 Hrs
Definitions of Monotone failure rates, mean residual function, checking for monotonicity of failure rates of above life distributions. Classes of life Distributions: IFR, IFRA, NBU, NBUE, DMRL and their inter-relationships. Characterization properties above classes of life distributions. Dual classes of IFR, IFRA, NBU, NBUE, DMRL.	
Unit 3: System Reliability and life testing:	15 Hrs
Series System, Parallel System, k-out-of-n system and Standby Redundant System. Reliabilities and their inter-relationships for these systems. Examples based on exponential and uniform distributions. **Life testing experiments:** Complete sample, Type I and Type II censorings (with replacement and without replacement). Distribution of observed observations in all these cases for exponential distribution.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1.Find reliabilities of various models of mechanical units (industry), biological science, health science, finance.	x	x	x	x					x	x		
CO2.Understand impact of age on functioning of systems.	x	x	x	x					x	x		
CO3. Know impact of configuration of sub-assemblies on performance	x	x	x	x					x	x		
CO4. Evaluate and analyse reliabilities of models.	x	x	x	x					x	x		

Pedagogy:

1.The course is taught using traditional chalk and talk method using problem solving through examples and exercises.

2. Students are encouraged to use resources available on open sources.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Test 1	15
Internal Test 2	15
Assignment/Seminar (7 marks)+Attendance(3marks)	10
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Barlow R.E. and Proschan F (1975): Statistical Theory of Reliability and Life Testing. Holt-Rinhart and Winston, New York.
2	Sinha S.K. and Kale B.K. (1990): Life Testing and Reliability Estimation. Wiley Eastern, New Delhi.
3	Mann N.R, Schaffer R.F and Singpurwalla N.D. (1974): Methods for Statistical Analysis of Reliability and Life Data. Wiley New York.
4	Zacks S (1992): Introduction to Reliability Analysis. Springer - Verlag, New York.
5	J.V. Deshpande and Sudha G. Purohit (2005): Lifetime data: Statistical Models and Methods. World Scientific.

Vocational courses

1. STAV1-T: A course on statistical software. (Excel/advanced Excel/R/Python/ and any other)
2. STAV2-T: Data analysis using primary data /Secondary data with R/Excel/ any software.