

B.Sc.in Statistics
Effective from 2023-24

| Sem. | Type of Course | Theory/Practical | Course Code | Course Title | Instruction hour/week | Total hours /sem | Duration of Exam | Marks | | | Credits |
|------|----------------|------------------|-------------|--|-----------------------|------------------|------------------|------------|------------|------------|-----------|
| | | | | | | | | Formative | Summative | Total | |
| V | DSCC-9 | Theory | 035 STA 011 | Matrix algebra and Regression analysis | 04hrs | 56 | 02hrs | 40 | 60 | 100 | 04 |
| | DSCC-10 | Practical | 035 STA 012 | Matrix algebra and Regression analysis | 04hrs | 56 | 03hrs | 25 | 25 | 50 | 02 |
| | DSCC-11 | Theory | 035 STA 013 | Analysis of variance and Design of experiments | 04hrs | 56 | 02hrs | 40 | 60 | 100 | 04 |
| | DSCC-12 | Practical | 035 STA 014 | Analysis of variance and Design of experiments | 04hrs | 56 | 03hrs | 25 | 25 | 50 | 02 |
| | Other subject | | | | | | | | | | 04 |
| | Other subject | | | | | | | | | | 04 |
| | Other subject | | | | | | | | | | 04 |
| | SEC-3 | Practical | 035 STA 061 | Machine Learning with R-programming | 04hrs | 56 | 03hrs | 25 | 25 | 50 | 02 |
| | Total | | | | | | | 275 | 375 | 650 | 26 |
| VI | DSCC-13 | Theory | 036 STA 011 | Statistical Inference-II | 04hrs | 56 | 02hrs | 40 | 60 | 100 | 04 |
| | DSCC-14 | Practical | 036 STA 012 | Statistical Inference-II | 04hrs | 56 | 03hrs | 25 | 25 | 50 | 02 |
| | DSCC-15 | Theory | 036 STA 013 | Sampling Methods, Official Statistics and Econometrics | 04hrs | 56 | 02hrs | 40 | 60 | 100 | 04 |
| | DSCC-16 | Practical | 036 STA 014 | Sampling Methods, Official Statistics and Econometrics | 04hrs | 56 | 03hrs | 25 | 25 | 50 | 02 |
| | Other subject | | | | | | | | | | 04 |
| | Other subject | | | | | | | | | | 04 |
| | Other subject | | | | | | | | | | 04 |
| | Internship-1 | Practical | 036 STA 091 | Data Science Internship /Project. | | | | 50 | 0 | 50 | 02 |
| | Total | | | | | | | 300 | 350 | 650 | 26 |

B.Sc. Semester–V

Discipline Specific Course (DSC)-9

Course Title: Matrix algebra and regression analysis

Course Code: 035 STA 011

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|-----------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-9 | Theory | 04 | 04 | 56hrs. | 2hrs. | 40 | 60 | 100 |

Course Outcomes (COs): At the end of the course students 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.

| Unit | Title: | 56. hrs/sem |
|----------------|--|----------------|
| Unit I | Algebra of matrices and determinants : 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 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. | 14 hrs |
| Unit II | Linear Algebra : 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. | 14 hrs |

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|----------------|--|--------|
| UnitIII | Simple linear regression : 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. | 14 hrs |
| UnitIV | Multiple linear regression : 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. | 14 hrs |

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
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.

| FormativeAssessmentforTheory | |
|--|----------------|
| AssessmentOccasion/type | Marks |
| InternalAssessmentTest1 | 10 |
| InternalAssessmentTest2 | 10 |
| Quiz/Assignment/SmallProject | 10 |
| Seminar | 10 |
| Total | 40Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

B.Sc. Semester–V

Discipline Specific Course (DSC)-10

Course Title: Matrix algebra and Regression analysis

Course Code: 035 STA 012

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-10 | Practical | 02 | 04 | 56hrs. | 3hrs. | 25 | 25 | 50 |

Course Outcomes (COs): At the end of the course, students will be able to:

CO1: Computation of rank, inverse, and Eigen values of higher order matrix

CO 2: Express Linear Regression models in Matrix form and model evaluation with software.

CO 3: Identify situation where linear regression is appropriate.

CO4: Build and fit linear regression models with software.

CO5: Interpret estimates and diagnostic statistics.

CO6: Produce exploratory graphs.

| Expt. No, | Title: | 56.hrs/ sem |
|-----------|--|-------------|
| 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 | |

Instruction to the Examiners

1. In case the University question papers are not available the external examiner shall prepare question papers for all the experiments, in consultation with the internal examiner.
2. No students shall be allowed for the examination without their Journal / Practical records, certified by the Staff in-charge and Head / Principal. If the Journal/ Practical record is not presented by the student, the Head/Principal shall issue a certificate stating that he/she has attended the regular practical's and his/her attendance is satisfactory (not less than 75% including 10% of extracurricular activities if applicable) and the candidate shall then be allowed to appear for examination. In such

cases the marks reserved, for the journal shall be deducted.

3. Candidates having an attendance record of less than 75 % (including 10% of extracurricular activities, if applicable) in that practical paper shall not be allowed to take the practical examination.
4. The Principal shall permit the students to take the examination as out of turn in any other batches only on technical reasons like overlapping of the timings with other subjects but not for any other personal reasons of the candidate including medical grounds.
5. No practical examination shall be conducted in the absence of an external examiner. Absence of external examiner if any is to be brought to the notice of the principal by the internal examiner to enable alternative arrangements to be made. The Principal shall appoint external examiners as per the instruction already given. If the internal examiner remains absent, the principal shall appoint another internal / external examiner. Under any circumstances, there shall not be two internal examiners for a given batch but two external examiners shall be allowed.

| FormativeAssessmentforPractical | |
|---|------------------------------|
| Assessment | Distribution of Marks |
| Solve any three questions out of given four questions manually and execute problems in R software, each carry 07 marks. | 21 |
| Viva Voce | 2 |
| Certified Journal | 2 |
| Total | 25Marks |
| <i>Formative Assessment as per UNIVERSITY guidelines are compulsory</i> | |

The same shall be used for semester end Examination

B.Sc. Semester–V

Discipline Specific Course (DSC)-11

Course Title: Analysis of variance and Design of experiments

Course Code: 035 STA 013

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-11 | Theory | 04 | 04 | 56hrs. | 2hrs. | 40 | 60 | 100 |

Course Outcomes (COs): At the end of the course, students will be able to:

- CO1 : Can learn Exploratory Data Analysis (EDA) basics for ANOVA appropriate data.
- CO2 : Learn fixed and random effect models and one-way and two-way classified data
- CO3 : Understand different designs (CRD, RBD, LSD) and missing plot techniques.
- CO4 : Understand the different factorial experiments.
- CO5 : Develop complete and partial confounding for factorial experiments.

| Unit | Title: | 56.Hrs/sem |
|----------|---|------------|
| Unit I | ANALYSIS OF VARIANCE: 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. | 14 hrs |
| Unit II | EXPERIMENTAL DESIGNS : 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. | 14 hrs |
| Unit III | FACTORIAL EXPERIMENT : 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 ³ factorial experiments in RBD. | 14 hrs |
| Unit IV | CONFOUNDING : Need for confounding. Types of confounding - Complete and partial, Confounding in a 2 ³ - factorial experiment in RBD and its analysis. | 14 hrs |

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.

| FormativeAssessmentforTheory | |
|--|----------------|
| AssessmentOccasion/type | Marks |
| InternalAssessmentTest1 | 10 |
| InternalAssessmentTest2 | 10 |
| Quiz/Assignment/SmallProject | 10 |
| Seminar | 10 |
| Total | 40Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

B.Sc. Semester–V

Discipline Specific Course (DSC)-12

Course Title: Analysis of variance and Design of experiments

Course Code: 035 STA 014

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-12 | Practical | 02 | 04 | 56hrs. | 3hrs. | 25 | 25 | 50 |

Course Outcomes (COs): At the end of the course, students will be able to:

- CO1 : Learn Perform basic computations of ANOVA with R-programming and interpret the results.
- CO2 : Carry out the Tukey pairwise mean comparison method and Learn about other pairwise mean comparison methods with R-programming.
- CO3 : Construct and evaluate an appropriate statistical model (CRD, RBD, LSD, etc.) in order to answer important scientific or business-related questions with R programming.
- CO4 : Sketch and interpret bar graphs and line graphs showing the results of studies with simple factorial designs with Statistical software's.
- CO5 : Perform analysis to distinguish between main effects and simple effects with Statistical software's and recognize when an analysis of simple effects is required.
- CO6 : Analyses Confounding, Partial and Total confounding in factorial experiment with Statistical software's.

| Expt. No, | Title: | 56.hrs/ sem |
|-----------|--|-------------|
| 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 22 factorial experiment using RBD layout. | |
| 8 | Analysis of 23 factorial experiment using RBD layout. | |
| 9 | Analysis of 23 factorial experiment using RBD layout (Complete confounding). | |
| 10 | Analysis of 23 factorial experiment using RBD layout (Partial confounding). | |

Instruction to the Examiners

1. In case the University question papers are not available the external examiner shall prepare question papers for all the experiments, in consultation with the internal examiner.
2. No students shall be allowed for the examination without their Journal / Practical records, certified by the Staff in-charge and Head / Principal. If the Journal/ Practical record is not presented by the student, the

Head/Principal shall issue a certificate stating that he/she has attended the regular practical's and his/her attendance is satisfactory (not less than 75% including 10% of extracurricular activities if applicable) and the candidate shall then be allowed to appear for examination. In such cases the marks reserved, for the journal shall be deducted.

3. Candidates having an attendance record of less than 75 % (including 10% of extracurricular activities, if applicable) in that practical paper shall not be allowed to take the practical examination.
4. The Principal shall permit the students to take the examination as out of turn in any other batches only on technical reasons like overlapping of the timings with other subjects but not for any other personal reasons of the candidate including medical grounds.
5. No practical examination shall be conducted in the absence of an external examiner. Absence of external examiner if any is to be brought to the notice of the principal by the internal examiner to enable alternative arrangements to be made. The Principal shall appoint external examiners as per the instruction already given. If the internal examiner remains absent, the principal shall appoint another internal / external examiner. Under any circumstances, there shall not be two internal examiners for a given batch but two external examiners shall be allowed.

| FormativeAssessmentforPractical | |
|---|------------------------------|
| Assessment | Distribution of Marks |
| Solve any three questions out of given four questions manually and execute problems in R software, each carry 07 marks. | 21 |
| Viva Voce | 2 |
| Certified Journal | 2 |
| Total | 25Marks |
| <i>Formative Assessment as per UNIVERSITY guidelines are compulsory</i> | |

The same shall be used for semester end Examination

B.Sc. Semester–V

Skill Enhancement Course: SEC-3

Course Title: Machine Learning with R-programming

Course Code: 035 STA 061

| Type of Course | Theory / Practical | Credits | Instruction hour/week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|-----------------------|---------------------------------------|------------------|----------------------------|----------------------------|-------------|
| SEC-3 | Practical | 02 | 04 | 56hrs. | 3hrs. | 25 | 25 | 50 |

Course Outcomes (COs): At the end of the course, students will be able to:

- CO1 : Develop an appreciation for what is involved in Learning models from data
- CO2 : Understand a wide variety of learning algorithms
- CO3 : Understand how to evaluate models generated from data
- CO4 : Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models

| Expt. No, | Title: | 56.hrs/sem |
|-----------|--|------------|
| 1 | Machine Learning Algorithms using Simple Linear Regression Model (Problem 1) | |
| 2 | Machine Learning Algorithms using Simple Linear Regression Model (Problem 2) | |
| 3 | Machine Learning Algorithms using Multiple Linear Regression Model (Problem 1) | |
| 4 | Machine Learning Algorithms using Multiple Linear Regression Model (Problem 2) | |
| 5 | Machine Learning Algorithms using Polynomial Regression Model (Problem 1) | |
| 6 | Machine Learning Algorithms using Polynomial Regression Model (Problem 2) | |
| 7 | Machine Learning Algorithms using Logistic Regression Model (Problem 1) | |
| 8 | Machine Learning Algorithms using Logistic Regression Model (Problem 2) | |
| 9 | Machine Learning Algorithms using Logit Transformation Model | |
| 10 | Machine Learning Algorithms using Decision Tree Learning Methods | |

References:

| | |
|----|--|
| 1. | Andreas M and Guido S (O'Reilly) (2016). Introduction to machine learning with Python. |
| 2. | Deborah Nolan and Duncan Temple Lang (2015). Data Science in R- A case studies approach to computational reasoning and problem solving, CRC Press. |
| 3. | Gareth J, Daniel W, Trevor, H and Tibshirani, R (2013). An Introduction to Statistical Learning with Application in R. |
| 4. | Zelterman, D. (2015). Applied Multivariate Statistics with R, Springer. |
| 5. | Nina Zumel and John Mount (2020), Practical Data Science With R, Second Edition, Manning Shelter Island. |

Instruction to the Examiners

1. Students have to explain in brief problem and model to be used with machine learning algorithm.
2. Out of the above TEN Machine learning algorithms students has to pick any one and answer it.
3. Execute R code of problem and write the report.

| FormativeAssessmentforPractical | |
|--|------------------------------|
| Assessment | Distribution of Marks |
| Problem and model adequacy description | 4 Marks |
| R-Code writing | 4 Marks |
| R-Code execution | 8 Marks |
| Report Writing | 4 Marks |
| Certified Journal Submission | 2 Marks |
| Viva-Voce | 3 Marks |
| Total | 25Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

The same shall be used for semester end Examination

B.Sc. in Statistics

VI Semester

W. e. f.: 2023-24

B.Sc. Semester–VI

Discipline Specific Course (DSC)-14

Course Title: Statistical Inference-II

Course Code: 036 STA 011

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative Assessment Marks | Total Marks |
|----------------|--------------------|-----------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-14 | Theory | 04 | 04 | 56hrs. | 2hrs. | 40 | 60 | 100 |

Course Outcomes (COs): At the end of the course, students 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 : Learn about UMP test, MLR property and Likelihood ratio tests.
- CO4 : Explore about sequential inference.
- CO5 : Learn about one sample and two sample nonparametric tests.

| Unit | Title: | 56.hrs/sem |
|----------|---|------------|
| Unit I | Statistical Decision Theory : 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. | 14 hrs |
| Unit II | Testing of Hypothesis-II : 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. | 14 hrs |
| Unit III | Sequential Inference : Need for sequential analysis, Wald's SPRT, ASN, OC Functions, examples based on Bernoulli, Poisson, Normal and exponential distributions. | 14 hrs |
| Unit IV | Nonparametric tests : 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 | 14 hrs |

| References : | |
|--------------|--|
| 1 | Berger, J. O. (1985): Statistical Decision Theory and Bayesian Analysis, 2 nd 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, 2 nd ed., Thomson Learning. |
| 5 | Rohatagi, V. K. : (2010): Statistical Inference, Wiley Eastern, New Delhi. |
| 6 | Rohatagi V. K. and A.K.Md.E Saleh(2008) An Introduction to Probability and statistics, 2 nd Ed. Wiley . |
| 7 | Hogg Mckean and Craig (2009) : Introduction to Mathematical Statistics, 6 th Edition, Pearson Prentce Hall. |

| FormativeAssessmentforTheory | |
|--|----------------|
| AssessmentOccasion/type | Marks |
| InternalAssessmentTest1 | 10 |
| InternalAssessmentTest2 | 10 |
| Quiz/Assignment/SmallProject | 10 |
| Seminar | 10 |
| Total | 40Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

B.Sc. Semester–VI

Discipline Specific Course (DSC)-15

Course Title: Statistical Inference-II

Course Code: 036 STA 012

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|-----------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-15 | Practical | 02 | 04 | 56hrs. | 3hrs. | 25 | 25 | 50 |

Course Outcomes (COs): At the end of the course, students will be able to:

CO1: construct UMP tests for some discrete and continuous distributions.

CO2: construct sequential probability ratio tests for some discrete and continuous distributions.

CO3: draw OC and ASN curves

CO4: know some important non-parametric tests

| Expt. No, | Title: | 56.hrs/sem |
|-----------|---|------------|
| 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. | |

Instruction to the Examiners

1. In case the University question papers are not available the external examiner shall prepare question papers for all the experiments, in consultation with the internal examiner.
2. No students shall be allowed for the examination without their Journal / Practical records, certified by the Staff in-charge and Head / Principal. If the Journal/ Practical record is not presented by the student, the Head/Principal shall issue a certificate stating that he/she has attended the regular practical's and his/her attendance is satisfactory (not less than 75% including 10% of extracurricular activities if applicable) and the candidate shall then be allowed to appear for examination. In such cases the marks reserved, for the journal shall be deducted.

3. Candidates having an attendance record of less than 75 % (including 10% of extracurricular activities, if applicable) in that practical paper shall not be allowed to take the practical examination.
4. The Principal shall permit the students to take the examination as out of turn in any other batches only on technical reasons like overlapping of the timings with other subjects but not for any other personal reasons of the candidate including medical grounds.
5. No practical examination shall be conducted in the absence of an external examiner. Absence of external examiner if any is to be brought to the notice of the principal by the internal examiner to enable alternative arrangements to be made. The Principal shall appoint external examiners as per the instruction already given. If the internal examiner remains absent, the principal shall appoint another internal / external examiner. Under any circumstances, there shall not be two internal examiners for a given batch but two external examiners shall be allowed.

| FormativeAssessmentforPractical | |
|---|------------------------------|
| Assessment | Distribution of Marks |
| Solve any three questions out of given four questions manually and execute problems in R software, each carry 07 marks. | 21 |
| Viva Voce | 2 |
| Certified Journal | 2 |
| Total | 25Marks |
| <i>Formative Assessment as per UNIVERSITY guidelines are compulsory</i> | |

The same shall be used for semester end Examination

B.Sc. Semester–VI

Discipline Specific Course (DSC)-16

Course Title: Sampling Methods, Official Statistics and Econometrics.

Course Code: 036 STA 013

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-16 | Theory | 04 | 04 | 56hrs. | 2hrs. | 40 | 60 | 100 |

Course Outcomes (COs): At the end of the course, students 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.

| Unit | Title: | 56.hrs/ Sem |
|---------|---|-------------|
| Unit I | <p>Introduction to sampling theory : 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.</p> <p>Simple random sampling : 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.</p> | 14 hrs |
| Unit II | <p>Stratified sampling and systematic sampling :</p> <p>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.</p> <p>Systematic Sampling: Linear systematic sampling Technique; estimates of population</p> | 14 hrs |

| | | |
|---------|---|--------|
| | <p>mean and total, variances of these estimates ($N=n \times k$).</p> <p>Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.</p> | |
| UnitIII | <p>National development: 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.</p> | 14 hrs |
| UnitIV | <p>Introduction to Econometrics:</p> <p>Origin, definition, methodology, scope and limitations of econometrics. Simple Econometrics models : assumptions and analysis.</p> <p>Analysis of Residuals : Presence of outliers omitted variables, nonlinear relationship, correlated disturbances, heteroscedasticity, Generalized Least Squares.</p> <p>Multicollinearity: The plausibility of the assumption of non-multicollinear regressors, consequences of multicollinearity, tests for detecting multicollinearity, solutions for multicollinearity.</p> | 14 hrs |

| 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. |
| 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 | Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi. |
| 9 | Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi. |
| 10 | Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi. |
| 11 | Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi. http://mospi.nic.in/ |
| 12 | Baltagi B.H. (2000) Econometrics, Springer. |

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| 13 | Gujarati D.N. (2003) Basic Conometrics, McGraw-Hill. |
| 14 | Maddala G.S. (2002) Introduction to Econometrics, John Wiley. |

| FormativeAssessmentforTheory | |
|--|----------------|
| AssessmentOccasion/type | Marks |
| InternalAssessmentTest1 | 10 |
| InternalAssessmentTest2 | 10 |
| Quiz/Assignment/SmallProject | 10 |
| Seminar | 10 |
| Total | 40Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

B.Sc. Semester–VI

Discipline Specific Course (DSC)-17

Course Title: Sampling Methods, Official Statistics and Econometrics.

Course Code: 036 STA 014

| Type of Course | Theory / Practical | Credits | Instruction hours per week | Total No. of Lectures / Hours / Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|----------------|--------------------|---------|----------------------------|--|------------------|----------------------------|----------------------------|-------------|
| DSCC-17 | Practical | 02 | 04 | 56hrs. | 3hrs. | 25 | 25 | 50 |

Course Outcomes (COs): At the end of the course, students will be able to:

CO1: To select a Simple random sample with and without replacement from a finite population and estimation of the mean and total and the standard error of the estimator.

CO2: To select a Stratified random sampling and Systematic Sampling from a finite population and estimation of the mean and total and the standard error of the estimator.

CO3: Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR and SRSWOR.

CO4: Compute and analyze Multiple linear regression models with R-codes by addressing the consequences of Multicollinearity and Diagnostics of Multicollinearity.

CO5: Compute and analyze Multiple linear regression models with R-codes by addressing the consequences of autocorrelation and heteroscedasticity.

| Expt. No, | Title: | 56.hrs/sem |
|-----------|---|------------|
| 1. | Drawing of random sample under SRSWOR and SRSWR from a given population and estimation of the mean and total and the standard error of the estimator. | |
| 2. | Construction of Confidence Intervals for mean and total for SRSWR and SRSWOR. | |
| 3. | Estimation of the proportion, total and the standard errors of the estimators based on a random sample under SRSWR and SRSWOR. | |
| 4. | Estimation of the mean, total and the standard error of the estimator under stratified random sampling. | |
| 5. | Exercise on allocation of samples in Stratified sampling. (Proportional Allocation and Neyman Allocation) | |
| 6. | Estimation of the mean, total and the standard error of the estimator under Systematic sampling. | |
| 7. | Estimation techniques in official statistics. | |
| 8. | Fitting of simple and multiple regression model | |
| 9. | Multiple regression model : detecting autocorrelation | |
| 10. | Multiple regression model : detecting multicollinearity | |

Instruction to the Examiners

1. In case the University question papers are not available the external examiner shall prepare question papers for all the experiments, in consultation with the internal examiner.
2. No students shall be allowed for the examination without their Journal / Practical records, certified by the Staff in-charge and Head / Principal. If the Journal/ Practical record is not presented by the student, the Head/Principal shall issue a certificate stating that he/she has attended the regular practical's and his/her attendance is satisfactory (not less than 75% including 10% of extracurricular activities if applicable) and the candidate shall then be allowed to appear for examination. In such cases the marks reserved, for the journal shall be deducted.
3. Candidates having an attendance record of less than 75 % (including 10% of extracurricular activities, if applicable) in that practical paper shall not be allowed to take the practical examination.
4. The Principal shall permit the students to take the examination as out of turn in any other batches only on technical reasons like overlapping of the timings with other subjects but not for any other personal reasons of the candidate including medical grounds.
5. No practical examination shall be conducted in the absence of an external examiner. Absence of external examiner if any is to be brought to the notice of the principal by the internal examiner to enable alternative arrangements to be made. The Principal shall appoint external examiners as per the instruction already given. If the internal examiner remains absent, the principal shall appoint another internal / external examiner. Under any circumstances, there shall not be two internal examiners for a given batch but two external examiners shall be allowed.

| FormativeAssessmentforPractical | |
|---|------------------------------|
| Assessment | Distribution of Marks |
| Solve any three questions out of given four questions manually and execute problems in R software, each carry 07 marks. | 21 |
| Viva Voce | 2 |
| Certified Journal | 2 |
| Total | 25Marks |
| <i>Formative Assessment as per UNIVERSITY guidelines are compulsory</i> | |

The same shall be used for semester end Examination

B.Sc. Semester–VI

INTERNSHIP

Course Title:Data Science Internship

Course Code:036STA091

| Type of Course | Theory /Practical | Credits | Instruction hour/week | Total No. of Lectures/Hours /Semester | Duration of Exam | Formative Assessment Marks | Summative assessment Marks | Total Marks |
|-------------------|-------------------|-----------|-----------------------|---------------------------------------|------------------|----------------------------|----------------------------|-------------|
| INTERNSHIP | Practical | 02 | 04 | 56hrs. | 3hrs. | 50 | 0 | 50 |

Course Outcomes (COs): At the end of the course students will be able to:

CO1:Accountable for individual and team responsibilities and deliverables.

CO2:Exercise the ability to compromise and problem solve with involved parties.

CO3:Apply computing theory, languages, and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses

CO4:Formulate and use appropriate models of data analysis tools to solve hidden solutions to business-related challenges

CO 5: Interpret data findings effectively to any audience, orally, visually, and in written formats.

| Expt. No | Title: | 56.hrs/sem |
|----------|---|------------|
| 1 | Identifying key areas of statistics useful to internship | |
| 2 | Develop and deliver engaging training sessions on various data science topics, including statistical analysis, machine learning, and data visualization | |
| 3 | Create comprehensive training materials, such as presentations and hands-on exercises, to facilitate effective learning for our students | |
| 4 | Provide guidance and support to students, helping them solve complex data science problems and reinforcing their understanding of key concept | |
| 5 | Collaborate to enhance and update curriculum, ensuring that it remains current and aligned with industry trends | |
| 6 | Conduct assessments and evaluations to measure student progress and identify areas for improvement, adapting teaching strategies accordingly | |
| 7 | Stay up-to-date with the latest developments in data science and technology | |
| 8 | Contribute to the growth and success of our education programs | |
| 9 | Writing visit reports, filing and collecting trial documentation | |
| 10 | Report writing | |

| FormativeAssessmentforPractical | |
|--|------------------------------|
| Assessment | Distribution of Marks |
| Analyze data using models and descriptive statistics | 10 |
| Participate in project planning | 10 |
| Contribute to project report | 10 |
| Collection of raw data | 10 |
| Produce tables/ figures/ interpretation | 10 |
| Total | 50Marks |
| <i>FormativeAssessmentasperguidelines.</i> | |

UG Programme: 2023-24

GENERAL PATTERN OF THEORY QUESTION COURSE FOR DSCC/ OEC

(60 marks for semester end Examination with 2 hrs duration)

Part-A

1. Question number 1-06 carries 2 marks each. Answer any 05 questions : 10 marks

Part-B

2. Question number 07- 11 carries 05Marks each. Answer any 04 questions : 20 marks

Part-C

3. Question number 12-15 carries 10 Marks each. Answer any 03 questions : 30 marks
(Minimum 1 question from each unit and 10 marks question may have sub questions for 7+3 or 6+4 or 5+5 if necessary)

Total: 60 Marks

Note: Proportionate weight age shall be given to each unit based on number of hours Prescribed

Internship for graduate Programme (As per UGC)

| | |
|----------------------|--|
| Course title | Internship Discipline specific |
| No. of contact hours | 90 |
| No. of credits | 2 |
| Method of evaluation | Presentation/Report of submission/Activity etc., |

- ❖ Internship shall be Discipline Specific of 90 hours (2 credits) with a duration 4-6 weeks.
- ❖ Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session).
- ❖ Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- ❖ The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- ❖ The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC guidelines.