ANNAMALAI UNIVERSITY

ANNAMALAINAGAR

DEPARTMENT OF STATISTICS

M. Sc. STATISTICS (CBCS)
(TWO YEAR ON-CAMPUS PROGRAMME)

HAND BOOK
REGULATIONS AND SYLLBI FROM 2014 -2015
Eligibility
Candidates for admission to the Two Year “M.Sc. Statistics” (CBCS) Degree Programme shall be required to have passed in B.Sc (Statistics) or B.Sc(Mathematics) or B.Sc (Computer Science) with at least two papers in Mathematics with a minimum of 50% marks.

Master Programme
A Master’s Programme consists of a set of Core courses and common course on soft skills and Optional papers.

The number and distribution of credits for core courses will be decided by the respective faculties.

Common courses, suggested by the respective departments, may be distributed in the first four semesters.

A course is divided into five units to enable the students to achieve modular and progressive learning.

Semesters
An academic year is divided into two semesters, Odd semester and Even semester. The normal semester periods are:

Odd semester: July to November (90 working days)
Even semester: December to April (90 working days)

Credit
The term credit is used to describe the quantum of syllabus for various programmes in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.

The minimum credit requirement for a Two year Master’s Programme shall be 90.

Courses
A course carrying one credit for lectures, will have instruction of one period per week during the semester, if four hours of lecture is necessary in each week for that course then 4 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lecture tutorials/laboratory work and other form of learning in a 15 week schedule:

i) One credit for each lecture period per week.
ii) One credit for every three periods of laboratory or practical work per week

Grading System
The term Grading System indicates a 10 point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

Duration
The duration for completion of a Two year Master’s Programme in any subject is Four semesters.

Attendance
Every teaching faculty handling a course shall be responsible for the maintenance of attendance register for candidates who have registered for the course.
Each student should earn 80% attendance in the courses of the particular semester failing which he or she will not be permitted to sit for the end-semester examination.

However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 80% attendance for valid reasons on payment of a condonation fee and such exemptions should not under any circumstance be granted for attendance below 70%.

**Examinations**

The internal assessment for each theory course carries 25% marks and practical course 40% of marks which is based on two internal tests and a variety of assessment tools such as seminar and assignment. The pattern of question paper will be decided by the respective faculty. **The tests are compulsory.**

For internal assessment evaluation, the break-up marks shall be as follows:

<table>
<thead>
<tr>
<th>Theory</th>
<th>Marks</th>
<th>Practical Marks</th>
<th>Project / Dissertation</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test-I</td>
<td>10</td>
<td>Test-I 15</td>
<td>Viva-Voce 40</td>
<td>25</td>
</tr>
<tr>
<td>Test-II</td>
<td>10</td>
<td>Test-II 15</td>
<td>Project Record 60</td>
<td>25</td>
</tr>
<tr>
<td>Assignment/Seminar</td>
<td>5</td>
<td>Record 10</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>Total 40</strong></td>
<td><strong>Total 100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

There will be one End Semester Examination (75% marks) of 3 hours duration for each theory course. The pattern of question paper will be decided by the respective faculty.

**Evaluation**

The performance of a student in each course is valuated in terms of Percentage of Marks (PM) with a provision for conversion to Grade Point (GP). The sum total performance in each semester will be rated by GPA while the continuous performance in Core, Allied and optional courses will be marked by (CGPA).

**Marks and Grading**

The student cannot repeat the assessment of sessional test I and sessional test II. However, if for any compulsive reason, the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A student has to secure 50% minimum in the End Semester Examination.

The student who has not secured minimum of 50% of marks (sessional plus end semester examination) in a paper shall be deemed to have failed in that paper.

A candidate who has secured a minimum of 50% marks in all the papers prescribed in the programme and earned 225 credits will be considered to have passed the integrated Master’s Programme.

**Grading** A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master’s Programme.

<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade Point</th>
<th>Letter Grade</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 +</td>
<td>10</td>
<td>S</td>
<td>Exemplary</td>
</tr>
<tr>
<td>85-89</td>
<td>9.0</td>
<td>D⁺</td>
<td>Distinction</td>
</tr>
<tr>
<td>80-84</td>
<td>8.5</td>
<td>D</td>
<td>&quot;</td>
</tr>
<tr>
<td>75-79</td>
<td>8.0</td>
<td>D⁻</td>
<td>&quot;</td>
</tr>
<tr>
<td>70-74</td>
<td>7.5</td>
<td>A⁺</td>
<td>First Class</td>
</tr>
</tbody>
</table>
Grade cards will be issued to the students, after the declaration of results. The grade card will contain the list of programmes registered during the semester, the grades scored and the Grade point Average for the semester.

GPA is the sum of the products of the number of credits of a programme with the grade point scored in that programme, taken over all the courses for the semester divided by the sum of the number of credits for all courses taken in that semester. CGPA is similarly calculated considering the core, allied and optional courses taken from I semester to IV semester.

The results of the final semester will be withheld until the student obtains passing grade in all the programmes of all earlier semesters.

The Candidates who are eligible to get the M.Sc degree in First class with distinction will be ranked on the basis of CGPA scored in Part-III Core, Allied and Optional Courses of Study from I Semester to IV Semesters.

The Candidates Passing with First Class will be ranked next to those with distinction on the basis of CGPA scored in Part-III Core and Optional courses of study from I Semester to IV Semesters.

Candidates who obtain **FIRST CLASS with Distinction** shall be deemed to have passed the examinations provided he/she passes all the papers prescribed for the programme at the **First Appearance**.

**TRANSITORY REGULATIONS**

Wherever there had been change of syllabi, examinations based on the existing syllabi will be conducted for three times consecutively after implementation of the new syllabi in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent programmes, as per the new syllabi, on the recommendations of the Head of the Department concerned.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the programmes of study and the syllabi from time to time.

**M.Sc., - STATISTICS (Two Year CBCS Course)**

<table>
<thead>
<tr>
<th>COURSE CODE</th>
<th>SUBJECT OF STUDY</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
<th>SEMESTER CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – Year: Semester – I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>STSC 101</td>
<td>Real Analysis and Measure Theory</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>STSC 102</td>
<td>Probability Theory</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
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</tr>
<tr>
<td>STSC 103</td>
<td>Sampling Theory</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
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</tr>
<tr>
<td>STSC 104</td>
<td>Programming with C++</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
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<tr>
<td>STSP 105</td>
<td>Practical – I</td>
<td>1</td>
<td>4</td>
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</tr>
<tr>
<td>I – Year: Semester – II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>STSC 201</td>
<td>Distribution Theory</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
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<tr>
<td>STSC 202</td>
<td>Estimation Theory</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<tr>
<td>SUBJECT CODE</td>
<td>SUBJECT TITLE</td>
<td>L</td>
<td>P</td>
<td>C</td>
<td>IA</td>
<td>EE</td>
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</tr>
<tr>
<td>STSC 203</td>
<td>Statistical Quality Control and Reliability</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>STSP 204</td>
<td>Practical – II</td>
<td>1</td>
<td>4</td>
<td>4</td>
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<td></td>
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<tr>
<td>MAMO 215</td>
<td>Optional – I – Numerical Methods</td>
<td>4</td>
<td>4</td>
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</table>

**II – Year: Semester – III**

<table>
<thead>
<tr>
<th>SUBJECT CODE</th>
<th>SUBJECT TITLE</th>
<th>L</th>
<th>P</th>
<th>C</th>
<th>IA</th>
<th>EE</th>
<th>TOTAL MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STSC 301</td>
<td>Testing of Statistical Hypotheses</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>STSC 302</td>
<td>Multivariate Statistical Analysis</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<tr>
<td>STSC 303</td>
<td>Operations Research</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<tr>
<td>STSP 304</td>
<td>Practical – III</td>
<td>1</td>
<td>4</td>
<td>4</td>
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<tr>
<td>MAMO 315</td>
<td>Optional – II – Discrete Mathematics</td>
<td>4</td>
<td>4</td>
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<tr>
<td>ENGO 316</td>
<td>Soft Skills</td>
<td>4</td>
<td>4</td>
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**II – Year: Semester – IV**

<table>
<thead>
<tr>
<th>SUBJECT CODE</th>
<th>SUBJECT TITLE</th>
<th>L</th>
<th>P</th>
<th>C</th>
<th>IA</th>
<th>EE</th>
<th>TOTAL MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STSC 401</td>
<td>Design and Analysis of Experiments</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>STSC 402</td>
<td>Stochastic Processes</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<td></td>
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</tr>
<tr>
<td>STSO 403</td>
<td>Optional – III – Applied Regression Analysis</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<tr>
<td>STSO 404</td>
<td>Optional – IV – Oracle and Java Programming</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<td></td>
<td></td>
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<tr>
<td>STSP 405</td>
<td>Practical – IV</td>
<td>1</td>
<td>4</td>
<td>4</td>
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<td></td>
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<tr>
<td>STSP 406</td>
<td>Project / Dissertation</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OVERALL CREDITS 90**

L – Lecture Hours   T – Tutorial Hours   P – Practical Hours   C – Credits

Total Core Courses and Practical Credits = 70
Total Optional & Soft Skill Credits = 20
Overall Credits = 90

Note: 1. Soft Skills is offered by English Department
2. Optional I, II, III, IV is Chosen either Internal Optional or from other Departments.

**OPTIONAL COURSE OFFERED TO OTHER DEPARTMENTS IN ODD AND EVEN SEMESTERS**

<table>
<thead>
<tr>
<th>SUBJECT CODE</th>
<th>SUBJECT TITLE</th>
<th>L</th>
<th>P</th>
<th>C</th>
<th>IA</th>
<th>EE</th>
<th>TOTAL MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional – I: STSO 01</td>
<td>STATISTICAL METHODS</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>25</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

**OPTIONAL COURSE OFFERED TO MATHEMATICS DEPARTMENT IN ODD AND EVEN SEMESTERS**

<table>
<thead>
<tr>
<th>SUBJECT CODE</th>
<th>SUBJECT TITLE</th>
<th>L</th>
<th>P</th>
<th>C</th>
<th>IA</th>
<th>EE</th>
<th>TOTAL MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional – II: STSO 02</td>
<td>MATHEMATICAL STATISTICS</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>25</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>
### List of Internal Optional Course

<table>
<thead>
<tr>
<th>Course code</th>
<th>Subject Title</th>
<th>Course Code</th>
<th>Subject Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STSO403</td>
<td>Applied Regression Analysis</td>
<td>STSO408</td>
<td>Actuarial Statistics</td>
</tr>
<tr>
<td>STSO404</td>
<td>Oracle and Java Programming</td>
<td>STSO409</td>
<td>Bayesian Inference</td>
</tr>
<tr>
<td>STSO405</td>
<td>Bio – Statistics</td>
<td>STSO410</td>
<td>Advance Econometrics</td>
</tr>
<tr>
<td>STSO406</td>
<td>Advance Stochastic Processes</td>
<td>STSO411</td>
<td>Time Series Analysis</td>
</tr>
<tr>
<td>STSO407</td>
<td>Statistical Decision Theory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## I YEAR – SEMESTER – I

### STSC 101: REAL ANALYSIS AND MEASURE THEORY

**OBJECTIVE:-**

To enrich the skills of students for learning the concepts and methods of matrices, Real analysis and Measure theory.

**UNIT I:**

Matrix, Rank of a matrix, Elementary transformation of a matrix, Invariance of rank through elementary transformation Theorem. Elementary transformation of a matrix do not alter its rank; Multiplication of the elements of a row by a non-zero number does not alter rank; Reduction to normal form; Elementary matrices; Elementary transformation and elementary matrices; Theorem; Employment of only row (column) transformations; The rank of a product; A convenient method for computing the inverse of a non-singular matrix A; Equivalence of matrices.

Characteristic root and Characteristic vectors of a square matrix; Nature of the characteristic roots special types of matrices; Mutual relations between characteristic vectors corresponding to different characteristic roots; The construction of orthogonal matrices and Construction of unitary matrices.

**UNIT II:**

Sequences and series of functions - Point wise convergence of sequences of functions; Uniform convergence of sequences of functions; Consequences of uniform convergence; Convergence and uniform convergence of series of functions; Integration and differentiation of series of functions; Abel summability; A continuous, nowhere-differentiable function. Three famous theorems; The metric space C [a, b]; The Weierstrass approximation theorem; Picard existence theorem for differential equations; The Arzela theorem on equicontinuous families.

**UNIT III:**

The Lebesgue integral - Length of open sets and closed sets; Inner and outer measure; Measurable sets; Properties of measurable sets; Measurable functions; Definition and existence of the Lebesgue integral for bounded functions; Properties of the Lebesgue integral for bounded measurable functions; The Lebesgue integral for unbounded functions; Some fundamental theorems; The metric space $L^2[a, b]$; The integral on $(-\infty, \infty)$ and in the plane.

**UNIT IV:**

Measure - Lebesgue outer measure; Integration of Functions of a real Variable; Integration of Non-negative Functions; The general integral; integration of series; Riemann and Lebesgue integrals. Differentiation; The four derivates; Continuous Non-differentiable functions; Functions of Bounded variation; Differentiation and Integration; The Lebesgue set.

**UNIT V:**

Signed Measure and their Derivatives - Signed measure and the Hahn Decomposition; The Jordan Decomposition; The Radon – Nikodym theorem and its applications. Lebesgue- Stieltjes measure; absolutely continuous functions; Integration by parts; Measure and Integration in a product space; Measurability in a Product space; The product measure and Fubini’s Theorem.
STSC 102: PROBABILITY THEORY

OBJECTIVE:-

- To build a foundation for the applications of Probability Concepts.

UNIT–I

General probability space; sigma algebra of events; Axiomatic Definition of probability: Random variable. Limit of a sequence of random variables induced probability space. Distribution function of a random variable: Decomposition of distribution function: Distribution functions of vector of random variables: Correspondence theorem.

UNIT–II

Expectation of a random variable Properties of Expectation; Moment; Inequalities involving moments: Convergence in probability; Convergence almost surely; Convergence in distribution: Convergence in rth monotone convergence theorem for expectation.

UNIT–III

Characteristic function and its properties; Inversion theorem; Characteristic function and moments; Khintchine Bochner’s theorem; Weak and complete convergence sequence of distribution functions; Convergence of a sequence of characteristic functions.

UNIT–IV

Independence of events, rule and properties: Zero one laws: Convergence of a series of independent random variables; Kolmogorov inequalities: Stability of Series of RV’s

UNIT–V


Book for Study and Reference:-


7
STSC 103: SAMPLING THEORY

OBJECTIVE:-

- To enrich the skills of students to get more specialization in various sampling procedures and for adopting the appropriate sampling technique in real life application and survey.

UNIT–I

Population and Sample; Notions of sampling and non-sampling errors; Sampling Unit–and sampling frame. Simple random sampling (SRS); from finite populations with and without replacement; Estimates of Mean, total and proportion and their standard errors; confidence intervals; Pooling of estimates; determination of sample size.

UNIT–II

Systematic Sampling (SYS); Method of estimation of population total and mean; Estimation of their sampling variances; Case of linear trends; comparison of SRS and SYS; circular systematic sampling; Stratified random sampling (STRS): Need for stratification; detailed study of Allocation problems; Stratified random sampling with and without replacement; Estimates of population total, mean and proportion and their standard errors, Gain due to stratification and its estimate from a sample. Comparison of Simple Random Sample, Systematic sample and Stratified sampling in the presence of linear trend.

UNIT–III

Varying probability sampling; PPS sampling with and without replacement; stratified PPS sampling; Gain due to PPS sampling; Selection procedures; ordered and unordered estimators; Desraj, Horvitz Thompson and Murthy’s Estimators.

Use of auxiliary information to estimating parameters; Two phase sampling. Ratio estimators; Notion of Ratio estimation: Bias in ratio estimator; Mean square error; Ratio estimators under the cases of simple random sampling and stratified random sampling. Regression estimators; Bias and variance; Regression estimators in the cases of simple random sampling and stratified random sampling.

UNIT–IV

Cluster sampling: Need for cluster sampling; Sampling with equal clusters, simple random sampling with varying probabilities under varying cluster sizes; their relative efficiency compared to SRS; optimum cluster size. Multistage sampling; Estimates of population mean and its sampling variance in two stage sampling with SRS.

UNIT–V

Planning and organization of sample surveys: Preparation of schedules, Analysis and Preparation of report. The nature and scope of samples surveys conducted in India by the National Sample Survey Organisation (NSS).

Books for Study and Reference:-

STSC 104: PROGRAMMING WITH C++

OBJECTIVES:-

- This paper aims at introducing the language C++ in a systematic manner to make the students to have knowledge in program writing and developing the software.

UNIT–I
C++: Introduction, Data types, Operators, Statements; Declaration of variables, Statements, simple C++ programs, Features of iostream.h, manipulation function, I/O stream flags.

UNIT–II
Control Statements: Conditional expression, Switch statement, loop statements, Breaking control statements; Functions and Program structures; Introduction, definition, Types of functions, Actual and Formal arguments, Default augments, Storage class specifiers, Recursive function, Pre-processors, Header files and standard function.

UNIT–III
Arrays: Notation, Declaration, Initialization, Processing, Arrays and Functions, Multidimensional arrays. Pointers; Declaration, Arithmetic; Pointers and Functions, Pointers and Arrays; Strings, Array of Pointers, Pointers to Pointers.

UNIT–IV
Structures: Declaration, Initialization, Functions, Array of structures, Arrays within a structure, Nested Structures, Pointers and Structures, Unions and Bit fields, Enumerations.

UNIT–V
Classes and Objects: Introduction, Structures and classes, Declaration, Members Functions, Object a class, Array of class objects, Pointers and Classes, Unions and Classes, nested Class, Constructors and Destructors, Inline Members functions and Friend Functions. C++ programs for Descriptive Measures of Statistics, ANOVA- One way and Two way Classifications.

Books for Study and Reference:-

STSP 105: PRACTICAL – I
(COMPUTER BASED PRACTICAL)

PRACTICAL SCHEDULE:-

SPSS
Descriptive Statistics.
Test for Single mean.
Test for difference of mean.
Paired t-Test.
ANOVA One-way Classification.
Two way ANOVA.
Chi-Square Test.
Principal Component Analysis.
Correlation and Regression (Simple and Multiple).
Factor Analysis.
Discriminant Function.
Cluster Analysis.
MATLAB
- Arithmetic operations on matrices (Addition, Subtraction, Multiplication).
- Inverse of a Matrix.
- Solving of simultaneous equations.

SYSTAT
- Descriptive Statistics.
- Correlation and Regression.
- Chi-Square Test.
- ANOVA One-way Classification.
- ANOVA Two-way Classification.

SIGMAPLOT
- Descriptive Statistics.
- Correlation and Regression.

STATGRAPH
- Diagrams and Graphs related to Statistical Data.
- Statistical Applications.

I YEAR - SEMESTER – II
STSC 201: DISTRIBUTION THEORY

OBJECTIVE:-
- To know the basic ideas of continuous and truncated distributions and to study the concepts of
  Bivariate distribution, Non-central t, F and \( \chi^2 \) and Beta distributions, Order statistics and
  quadratic forms.

UNIT–I
- Detailed Study of Binomial; Poisson; Normal; exponential; Gamma; Beta; Weibull; Logistic;
  Cauchy distributions (derivations; properties; Moments C.F and Applications); Concept of truncated
  distributions and Compound distribution.

UNIT–II
- Bivariate distribution; Concept of joint, Marginal and conditional distribution; Functions of
  random variables and their distributions; Maximum and minimum, sum, difference, product and
  quotient of random variables; Various techniques of finding distributions of functions of random
  variables; Distribution of functions involving several random variables.

UNIT–III
- Non-Central t, F, \( \chi^2 \) and Beta distribution - Properties of these distributions, Sampling
  distributions of mean, correlation and regression coefficients for normal samples (null case).

UNIT–IV
- Order statistics: cumulative distribution function of a single order statistics, p.d.f of a single
  order statistics, Joint p.d.f of a order statistics, Joint p.d.f of \( t^{th} \) order statistics, Joint p.d.f of n order
  statistics,; Distribution of range, mid range and Quantiles.

UNIT–V
- Quadratic forms for normal variables; Distribution of Quadratic forms: Conditions for
  independence of quadratic forms and linear forms, Cochran’s theorem. (Without proof) and its
  application.

Books for Study and Reference:-

**STSC 202: ESTIMATION THEORY**

**OBJECTIVE:**
- To enhance the methods of diagnosis of statistical estimation of parameters.

**UNIT-I**

- **Unbiasedness and Consistency** – Point Estimation, Highest Concentration Criterion, Minimum MSE Criterion, Unbiased Estimators, Quenoulli’s Method of Reducing the Bias in Stages, Consistent Estimator, BAN Estimator and Case of Several Parameters. Problems and Exercises. (Contents as in Chapter -2 of Book-1)

**UNIT-II**

- **Sufficiency and Completeness** : Sufficient Statistics, Fisher Information Measure, Neyman-Fisher Factorization Theorem, Minimal Sufficient Statistics, Complete Statistics, Exponential Family of Distributions, Pitman’s Family of Distributions. Problems and Exercises. (Contents as in Chapter -3 of Book-1)

**UNIT-III**

- **Minimum Variance Unbiased Estimators**: Case of a single parameter, Lower Bounds for Variance of Unbiased Estimators (Cramer-Rao Inequality) UMVUE, Bhattacharya Inequality, Chapman-Robin’s Inequality, Rao-Blackwell theorem, Lehman- Sheffee Theorem. Use of Sufficient and Complete Statistics, Case of Several Parameters. Problems and Exercises. (Contents as in Chapter -4 of Book-1)

**UNIT-IV**


**UNIT-V**

- **Internal Estimation** : A general Method of Constructing Confidence Intervals (CIs), Construction of Shortest Average Width CIs, Construction of CIs in Large Samples, Construction of Most Accurate CIs, Construction of Bayesian CIs, Problems and Exercises. (Contents as in Chapter -6 of Book-1)
Books for Study and Reference:-


STSC 203: STATISTICAL QUALITY CONTROL AND RELIABILITY

OBJECTIVES:-

- This paper gives an exposure to various concepts in statistical quality control and the notions of reliability theory are the components to be dealt with in this paper.

UNIT–I

Meaning and scope of statistical quality control; causes of quality variation, statistical basis for control charts, choice of control limits, sample size and sampling frequency, rational subgroups, specification, tolerance and warning limits. Construction and operations of $\bar{X}$, R and $\sigma$ charts, np, p, c and u charts, Operating Characteristic curves for control charts.

UNIT–II

Principles and construction of modified control charts, cumulative sum control chart, Basic principles and design of CUSUM charts, concept of V-mask, one and two sided decision procedures. Moving-average and geometric moving-average control chart, sloping control charts.

UNIT–III

Acceptance sampling plans, Rectifying inspection, Sampling Inspection by Attributes, Concept of OC, ASN, ATI, AOQ functions of sampling plans, AQL, LTPD, producer’s risk and consumer’s risk on OC curve. Operation and use of single, double and multiple sampling plans. MIL STD-105D Standard, Dodge and Romig Sampling Plans.

UNIT–IV

Sampling inspection by variables - known and unknown sigma, Variable sampling plan, merits and demerits of variable sampling plan, derivation of OC curve. Determination of parameters of the plan. Continuous sampling plans by attributes, CSP-1, CSP-2 and CSP-3. Concept of AOQL in CSPs and Multi-level continuous sampling plans, Indian Standards ISO 2000 (concepts only).

UNIT–V


Books for Study and Reference:-

STSP 204: PRACTICAL – II
(CALCULATOR BASED PRACTICAL)

Practical Schedule:-

Sampling

- Estimation of sample mean and sample variance under simple random sampling without replacement.
- Estimation of sample mean and sample variance under SRSWR.
- Estimation of Proportion under SRSWOR.
- Estimation of Population total, mean and variances under systematic sampling.
- Estimation of mean, variances under stratified random sampling.

Statistical Quality Control

- Control Chart for $\bar{X}$ and $R$
- Control Chart for $\bar{X}$ and $\sigma$
- $N_p$ – Control Chart
- $P$ – Chart
- $C$ – Chart
- $U$ – Chart
- Single sampling plan – OC, ASN, ATI and AOQ.

Multivariate Analysis

- Estimation of Mean vector and Covariance Matrix.
- Test for the Mean vector when Covariance Matrix is known.
- Test for Equality of Mean vector.
- Test for the Mean vector when Covariance Matrix is unknown.
- Test for Covariance Matrix.
- Test for Equality Covariance Matrices.

OPTIONAL – I – MAMO 215: NUMERICAL METHODS

Objectives: The role of numerical analysis is to develop and analyze the numerical techniques. In this paper, different methods for finding the roots of algebraic and transcendental equations, solutions of simultaneous equations, solutions of differential equations are concentrated. Numerical differentiation and integration are also evaluated.

UNIT - I: The solution of Numerical Algebraic and Transcendental Equations:
UNIT - II: Simultaneous Linear Algebraic Equations:
Gauss Elimination method, Computation of the inverse of a matrix using Gauss elimination method, Method of Triangularisation (Method of Factorization), Crout's method, Iterative methods, Jacobi method of iteration (Gauss-Jacobi Method), Gauss Seidal method of iteration.

UNIT - III: Interpolation:
Introduction, Linear interpolation, Gregory Newton Forward and Backward interpolation formula, Equidistant terms with one or more missing values.

Interpolation with unequal intervals:
Divided Differences, Properties of Divided differences, Newton's interpolation formula for unequal intervals, Lagrange's interpolation formula, Inverse interpolation.

UNIT - IV: Numerical Differentiation and Integration:
Introduction, Newton's forward difference formula to compute the derivatives, Newton's backward difference formula to compute the derivatives, Derivatives using Stirling's formula.
Trapezoidal rule, Simpson's rule, Practical applications of Simpson's rule, Trapezoidal rules.

UNIT - V: Numerical Solution of Ordinary Differential Equations:

TEXT BOOK
Chapters - III, IV, VI, IX, XI.

REFERENCE BOOKS

II YEAR - SEMESTER - III
STSC 301: TESTING OF STATISTICAL HYPOTHESES

OBJECTIVE:-
• The object is to acquire knowledge on advancements for making decisions based on statistical hypotheses.

UNIT-I
Tests of Hypotheses – Concepts, Test functions Non-randomized and randomized tests, Critical region, Two types of errors, level of significance , size and power of the test Neyman-Pearson Theory and Lemma, Test Functions or Critical Functions, MP tests when H and K are simple, Uniformly Most Powerful Tests, monotone Likelihood Ratio Property, Problems and Exercises. (Contents as in Chapter -7 of Book-1)

UNIT-II
UMP Tests - Monotone likelihood ratio property, Generalized NP lemma, Tests for One Parameter Exponential Family of Distributions, Locally Most Powerful Tests, UMPU Tests for Multi-Parameter Exponential Family of Distributions, Tests with Neyman’s Structure, Problems and Exercises. (Contents as in Chapter -8 of Book-1)

UNIT-III
Likelihood Ratio Method of Test Construction- Likelihood Ratio (LR) Test, Asymptotic Distribution of the LR test Criterion, LR test for testing the mean and variance of the Normal distribution based on K-samples(K≥1),Test Consistency, LR Test when Domain of RV Depends on Parameter, Problems and Exercises. (Contents as in Chapter -9 of Book-1)
UNIT-IV


UNIT-V

**Sequential Procedures:** Sequential Estimation- Sequential Hypothesis Testing, SPRT, Determination of the Constants of B and A for the SPRT, OC and ASN function of the SPRT. Certain Basic Results for SPRT, SPRTs When the Hypotheses are Composite, Basic results of SPRT, Decision intervals under SPRT for Binomial, Poisson and Normal distribution, Problems and Exercises. (Contents as in Chapter -13 of Book-1)

**Books for Study and Reference:**

**STSC 302: MULTIVARIATE STATISTICAL ANALYSIS**

**OBJECTIVE:**
- To understand the basic concepts of Multivariate analysis for applying more than two dimension situation.

**UNIT–I**
Estimation of the Mean vector and the covariance matrix in Multivariate normal distribution: Maximum likelihood estimates of the Mean vector and the covariance matrix, distribution of the sample mean vector, inference concerning the mean when the covariance matrix is known, tests and confidence regions for mean vectors and variance –covariance matrix are known, sufficient statistics for mean vectors and variance –covariance matrix

**UNIT–II**

Wishart distribution: Distribution (No derivation), characteristic function, properties, Marginal distributions, Linear transformation, sum of Wishart Matrices.

**UNIT–III**
Classification of observations: The problem of classification, standards of good classification, procedure of classification into one of two populations with known probability distributions, classification into one of two known multivariate normal populations, discriminant function,
classification into one of several populations, classification into one of several multivariate normal populations.

UNIT–IV
Principal components: Introduction, definition of principal components in the population, MLE of the principal components and their variances, computation of the MLE of the principal components. Canonical correlations and canonical variables: Introduction canonical correlations and variables in the population, estimation of canonical correlations and variables, computation.

UNIT–V
Factor Analysis: The Basic model common and special factor; communality; Estimation of factor loading principal factor method; maximum likelihood method; Factor Rotations; Cluster Analysis: Similarity and distance measures hierarchical clustering techniques.

Book for Study and Reference:-

STSC 303: OPERATION RESEARCH

OBJECTIVE:-
- To import knowledge of various optimization techniques that makes use of statistical concepts abundantly. The Optimization techniques which do not involve Statistical concepts are included in OR-I. On the other hand, in this paper those optimization techniques involving the Statistical concepts, especially the probability principles are taught.

UNIT–I
The General Linear Programming problem (GLPP): properties and solutions of the LPP; generating development of optimal feasible solutions; theory and computational algorithms of simplex method; degeneracy procedures and perturbation technique. Primal and dual LPP and duality theorem; Methods using artificial variables.

UNIT–II
Introduction, Limitation of integer LP, Methods of Integer programming: Cutting plane method, search methods-Branch and Bound techniques, Mixed Integer programming problem, Goal programming- formulation of problem and optimum solution.

UNIT–III
Theory of games: zero sum two person games; pure and mixed strategies; saddle points; LPP and games; graphical solutions of 2xn and mx2 games; dominance property; minimax and maximin and saddle point theorems.
UNIT–IV

Network analysis by CPM/PERT: Basic Concept - Constraints in Network – Construction of the Network – Time calculations – Concept of slack and float in Network Analysis – Network crashing – Finding optimum project duration and minimum project cost.

UNIT–V

Concept of scientific inventory management and analytical structure of inventory problems. The ABC inventory system - Costs associated with inventory - Deterministic inventory models - Economic lot size models - Stochastic inventory models with and without lead time.

Books for Study and Reference:-

STSP 304: PRACTICAL – III
(COMPUTER BASED PRACTICAL)

Practical Schedule:-

Programs Using C++

- Finding the mean and standard deviation for raw data.
- Finding the mean and standard deviation for discrete type frequency distribution.
- Finding the mean and standard deviation for continuous type frequency distribution.
- Finding the median for raw data.
- Finding the Skewness and kurtosis based on moments.
- Finding the correlation – coefficient.
- Finding the regression equations.
- Testing for population mean.
- Testing for difference of means.
- Paired t – Test.
- Chi-Square test for testing the independence of attributes.
- F – Test for equality of Variances.
- Fitting of Binomial Distribution and goodness of Fit.
- Fitting of Poisson Distribution and goodness of Fit.
- Fitting of Normal Distribution and goodness of Fit.
Optional – II – MAMO 315: DISCRETE MATHEMATICS

Objectives: Students must understand mathematical reasoning in order to read, comprehend and construct mathematical arguments. Mathematical logic, which serves as foundation for subsequent discussion is discussed. Discrete structures such as sets and permutations are studied. Discrete probability, recurrence relations, conquer relations and principles of inclusion and exclusion are studied.

UNIT I: Logic and Counting:
Propositions and logical operations, Conditional statements, Methods of Proof, Mathematical Induction. Permutations, Combinations, Pigeonhole Principle, Elements of Probability, Recurrence Relations.

UNIT II: Relations and Digraphs:
Product sets and partitions, Relations and Digraphs, Paths in Relations and Digraphs, Properties of relations, Equivalence Relations, Computer Representation of Relations and Digraphs, Operations on Relations, Transitive Closure and Warshall's Algorithm.

UNIT III: Functions:
Functions, Functions for Computer Science, Growth of Functions, Permutation Functions.

UNIT IV: Order Relations and Structures:

UNIT V: Semigroups and Groups:
Semigroups, Product and Quotient of Semigroups, Groups, Product and Quotient of Groups.

TEXT BOOK

Unit I: Chapter 2 Sections 1 to 4, Chapter 3 Sections 1 to 5.
Unit II: Chapter 4 Sections 1 to 8.
Unit III: Chapter 5 Sections 1 to 4.
Unit IV: Chapter 6 Sections 1 to 6.
Unit V: Chapter 9 Sections 1 to 4.

REFERENCE BOOKS
ENGO 316: SOFT SKILLS

OBJECTIVES:

- Soft skills evolve the personality of a person and prepare him/her for competition in the changing employment market elsewhere. A degree from a university is a basic requisite for job but an acquirement of soft skills will boost the employment opportunities of a person. The skills, when acquired, will change the attitude of people and make them approach life with best.

UNIT-I Personality Development

Personal Effectiveness Skills- Managerial and Supervisory Skills – Leadership Skills- Creativity Skills- Problem Solving Skills – Team Spirit – Culture Building.

UNIT-II Effective Listening


UNIT –III Interpersonal Communication


UNIT –IV Public Speaking


UNIT-V Writing Skills


Text Books and Reference:

II- YEAR - SEMESTER - IV
STSC 401: DESIGN AND ANALYSIS OF EXPERIMENTS

OBJECTIVE:-

- To enrich the basic principles of design of experiments, general designs, multiple comparison tests, factorial and incomplete block designs and their applications.

UNIT–I

Principles of Scientific experimentation; pen and plot techniques; Replication, Randomization and Local control; Notion of a design matrix, Inter and intra block analysis for general designs models, C matrix and its properties, Two way elimination of heterogeneity; Orthogonality; connectedness and resolvability.

UNIT–II

Detailed analysis of CRD, RBD, LSD, GREACO LSD - Expected values of the various sum of squares to be obtained, comparison of CRD, RBD and LSD - one and more observations per cell for RBD, Analysis of Higher order orthogonal LSD, Analysis of covariance (one concomitant variable) in CRD, RBD and LSD.

UNIT–III

Multiple comparison tests; meaning and need; Detailed description of CD, SNK, DMR and Tukey tests. Missing plot analysis of RBD and LSD; Mixed plot analysis of RBD (with one observation per cell); Cross- over designs and their analysis; Analysis of incomplete LSD.

UNIT–IV

Factorial Experiments; their needs and advantages, definition of symmetric factorials; meaning of main effects and interactions in 2^n and 3^n experiments; method of splitting factorial effects into orthogonal components; Complete analysis of such Experiments laid out in CRD, RBD and LSD. Need and meaning of confounding; total, partial and mixed confounding; Construction and analysis of such designs. Split plot and strip plot designs (in RBD & LSD only).

UNIT–V

Balanced and partially balanced incomplete Block design (with two associate classes only); their meaning, definition, classifications and analysis. Youden square design, its description and analysis; Lattice design, its definition, construction and Analysis of simple and Balanced Lattices.

Books for Study and Reference:-

STSC 402: STOCHASTIC PROCESSES

OBJECTIVE:-

- To acquire the standard concepts and methods of Stochastic Modelling, Analysis the variability that are inherent in Natural, Engineering and Medical Sciences and to provide new perspective, models and intuition and aid in other mathematical and statistical studies.

UNIT–I
Stochastic Processes: Definition and examples; Classification of stochastic processes with illustrations. Gambler’s ruin problem Markov chains; Definition and examples; One and two dimensional random walk; Transition probabilities; Classification of states; Recurrent Markov Chains; Necessary and sufficient condition for a state to be recurrent; Basic limit theorems on recurrence. Statistical Inference for Markov chains.

UNIT–II
Basic limit theorems of Markov chains. Theorem establishing the stationary probability distribution of a positive recurrent, a periodic class a states; Absorption probabilities; Criteria for recurrence, examples.

UNIT–III
Continuous time Markov chains; Examples, General pure birth process; Poisson process. Definition; and properties; Birth and death process with absorbing states; Finite state continuous time Markov chains.

UNIT–IV

UNIT–V
Queuing processes; General Description M/M/1 models with finite and infinite capacities Waiting time and busy period for both steady state transient behavior; Birth and Death Processes in queuing theory; Multi-channel model M/M/S; Embedded techniques applied to M/G/I and GI/M/I as particulars cases; Erlangian Queues.

Books for Study and Reference:

OPTIONAL – III – STSO 403: APPLIED REGRESSION ANALYSIS

OBJECTIVE:-

- To study the various regression models and their applications.

UNIT–I
Linear regression: Fitting a straight line, Precision of the estimated regression Coefficient of regression equation, lack of fit and pure error, simple Correlation, inverse regression.

UNIT–II
Fitting of straight line by matrix method (General Linear model), Analysis of variance, The general regression situation with and without distributional assumptions. General linear hypothesis.
testing in regression situation weighted least squares bias in regression estimates, restricted least squares.

UNIT–III
Multiple regression analysis: Estimation of parameters, Three variable model, partial regression Coefficient, OLS and ML estimation, Coefficient of multiple $R^2$ and adjusted $R^2$. Cobb-Douglas production function, polynomial regression models, partial correlation coefficients.

UNIT–IV
Multiple regression analysis: Hypothesis testing about individual regression coefficients, testing the overall significance of the sample regression, testing the equality of two regression coefficients, restricted least squares, Chow test, prediction with multiple regression, testing the functional form of regression.

UNIT–V
Dummy variable regression models: ANOVA and ANACOVA models, The dummy variable alternative to the Chow test, interaction effects using dummy variables, use of dummy variables in seasonal analysis, piecewise linear regression, panel data regression models.

Books for Study and Reference:-

OPTIONAL – IV – STSO 404: ORACLE AND JAVA PROGRAMMING

OBJECTIVES:-
- This paper aims at introducing the language Oracle and Java in a systematic manner to make the students to have knowledge in program writing and developing the software.

UNIT–I

UNIT–II

UNIT–III
Introduction to Java: Overviews of Java – Data types – Variables and arrays – operators – Control Statements – looping statements.

UNIT–IV
UNIT-V

Books for Study and Reference:-

STSP 405: PRACTICAL – IV
(CALCULATOR BASED PRACTICAL)

Practical Schedule
Testing of Hypotheses
- Most powerful test Estimation of power and size.
- Uniformly MP test – Estimation of power and size.
- One sample kolmogorov – Smirnov test.
- Sign test.
- Wilcoxon signed rank test.
- Kolmogorov – Smirnov two sample test.
- Median test.
- Kruskal – Wallis test.
- SPRT – OC and ASN curve for Binomial Distribution.

Design of Experiments
- Completely Randomized Design.
- Randomized Block Design.
- RBD with more than one observation per cell.
- Latin Square Design.
- Graccco – Latin Square Design.
- Missing Plot Analysis in CRD, RBD and LSD.
- Multiple Comparison Test – DMRT, LSD and CD.
- Efficiency of RBD over CRD.
- Efficiency of LSD over RBD and CRD.
- 2^2 – Factorial Experiment.
- 2^3 - Factorial Experiment with complete confounding.
- 2^3 - Factorial Experiment with partial confounding.
- 3^2 - Factorial Experiment
- Split – Plot Design.

Operation Research
- Linear Programming Problem – Simplex Method.
- Two Pearson Zero Sum Games.
- Network – CPM.
- Network – PERT.
STSO 01: STATISTICAL METHODS
(EXTERNAL OPTIONAL)

(OPTIONAL PAPER OFFERED TO OTHER DEPARTMENTS FROM DEPARTMENT OF STATISTICS)

(This is a Common optional paper offered to all other Branches of Faculty of Arts, Faculty of Science and Faculty of Marine Sciences. It can be chosen either in Odd Semester or Even Semester of their Two year CBCS P.G courses from the year 2014-15).

Unit – I
Definition, scope, functions and limitations of Statistics – Collection, Classification, Tabulation of data, Diagrammatic representation of data – Simple, Multiple and Percentage Bar diagram, Pie diagram and Graphical representation of data – Histogram, frequency polygon, frequency curve and ogives. Primary and Secondary data – Questionnaire method.

Unit – II

Unit – III

Unit – IV
Tests of Significance with their important concepts. Tests for large samples - Test for mean, difference of means, proportion and equality of proportions. Small sample tests – Test for mean, difference of Means, paired samples, test for correlation and regression coefficients, Chi square test for goodness of fit and independence of attributes.

Unit - V
Applications and analysis using SPSS – Analysis of variance one way and two way classifications. Multiple regression analysis, Logistic regression analysis, Factor analysis, Cluster analysis, Discriminant function analysis.

Note: The emphasis is only on the application of the methods. The derivations of the formulae are not necessary.

Books for Study and References :
STSO02: MATHEMATICAL STATISTICS
(EXTERNAL OPTIONAL)
(OPTIONAL PAPER OFFERED TO DEPARTMENT OF MATHEMATICS FROM DEPARTMENT OF STATISTICS)
(This paper is offered to M.Sc (Mathematics) (Two year (CBCS) course) from the year 2014-15)

UNIT-I


UNIT-II


UNIT-III

Generating Functions – Moment Generating Function- Limitations, Properties, Uniqueness Theorem, Cumulants - Properties, Characteristic Function- Properties of Characteristic Function, Necessary and Sufficient Conditions for a Function ϕ(t ) to be Characteristic Function, Some Important Theorems – Inversion Theorem, Uniqueness Theorem of Characteristic Functions, Necessary and Sufficient Condition for independence of Random Variables in Terms of Characteristic Functions, Halley –Bray Theorem, Continuity Theorem for characteristic Functions, Chebychev’s Inequality, Problems and Exercises. (Content as in Chapter-7 of Book 1)

UNIT-IV

Discrete Probability Distributions - Binomial, Poisson, Negative Binomial, Geometric, Hyper geometric, Multinomial Distributions and theirs –Moments, Recurrence, MGF, Additive Properties, Characteristic Functions, Recurrence Relations, PGF, Problems and Exercises. (Content as in Chapter-8 of Book 1)

UNIT-V

Continuous Probability Distributions – Normal, Rectangular, Gamma, Beta, Exponential, Standard Laplace, Cauchy Distributions, Sampling Distributions of t,F, Chi-Square and their Derivations, Moments, Additive Properties, Characteristic Functions, MGF, PGF, Inter-relationships. Central limit Theorem (Statement Only). (Content as in Chapter-9 of Book 1)

Books for Study and Reference:-
INTERNAL OPTIONAL PAPERS

STSO 403: APPLIED REGRESSION ANALYSIS

OBJECTIVE:-

- To study the various regression models and their applications.

UNIT–I

Linear regression: Fitting a straight line, Precision of the estimated regression Coefficient of regression equation, lack of fit and pure error, simple Correlation, inverse regression.

UNIT–II

Fitting of straight line by matrix method (General Linear model), Analysis of variance, The general regression situation with and without distributional assumptions. General linear hypothesis testing in regression situation weighted least squares bias in regression estimates, restricted least squares.

UNIT–III

Multiple regression analysis: Estimation of parameters, Three variable model, partial regression Coefficient, OLS and ML estimation, Coefficient of multiple R² and adjusted R². Cobb-Douglas production function, polynomial regression models, partial correlation coefficients.

UNIT–IV

Multiple regression analysis: Hypothesis testing about individual regression coefficients, testing the overall significance of the sample regression, testing the equality of two regression coefficients, restricted least squares, Chow test, prediction with multiple regression, testing the functional form of regression.

UNIT–V

Dummy variable regression models: ANOVA and ANACOVA models, The dummy variable alternative to the Chow test, interaction effects using dummy variables, use of dummy variables in seasonal analysis, piecewise linear regression, panel data regression models.

Books for Study and Reference:-


STSO 404: ORACLE AND JAVA PROGRAMMING

OBJECTIVES:-

- This paper aims at introducing the language Oracle and Java in a systematic manner to make the students to have knowledge in program writing and developing the software.

UNIT–I

UNIT–II

UNIT–III
Introduction to Java: Overviews of Java – Data types – Variables and arrays – operators – Control Statements – looping statements.

UNIT–IV

UNIT–V

Books for Study and Reference:-

STSO 405: BIO STATISTICS

OBJECTIVE:-
- To enrich the skills of students to get more applied knowledge in Bio Statistics.

UNIT–I
Epidemiology – Measures of disease frequency; Mortality and morbidity rates; Incidence rates; Prevalence rates; Source of mortality and morbidity statistics – hospital record, s Vital; statistics; Measure of accuracy; Sensitivity index; specificity index, Types of studies; Cross sectional Prospective, case control and clinical trials.

UNIT–II
Epidemiology – Measures of association relative risks odds ratio and their confidence interval; Statistical techniques used in analysis Confounding and interaction (definition only), Adjustment for confounding – Mantelenzel procedure, Logistic regression approach.

UNIT–III
Bioassay, direct assays: quantitative dose – response relations: estimation of median effective dose, estimation of unknown concentration of potency, probit and logit transformation, structure for parallel line assays.

UNIT–IV
Bioassay: principles of planning an assay; slope ratio assays, efficiency in slope ationassays, quantal responses and the tolerance distributions, Assays, based on quantal responses, Symmetric and asymmetric assays.

UNIT–V
Survival analysis: purpose and scope: survival function, hazard function and their relationships, censoring – Type I and II (definition only), Nonparametric methods estimating survival distributions; Analysis estimation procedures (exponential, Weibull, lognormal and gamma cases).
Books for Study and Reference:-

STSO 406: ADVANCED STOCHASTIC PROCESSES

AIM: To motivate the Students for further study in advanced topics of Stochastic process.

UNIT–I

UNIT–II

UNIT–III
Stochastic processes in queuing: queuing systems, General concepts, M/M/1 Queuing model, Steady state behavior, Transient behaviours, Birth and death processes in queuing theory, Multichannel model, Non-birth and death queuing processes, Bulk queues, Non-Markovian queuing, Model G1/M/1 model; queues with vacation, Discrete – time queues (Concept only)

UNIT–IV
Taboo probabilities, ratio theorems, and Existence of generalized stationary distribution, continuous time Markov chain, differentiability properties of transition probabilities, Forward and Backward differential equations, construction of a continuous time Markov chain from its infinitesimal parameters.

UNIT–V
Regular, inter regular and sub-regular sequences for Markov chain, sums of independent random variables as a Markov chain, recurrence properties, Local limit theorems.

Books for Study and Reference:-
5. Bharucha Reid, A.T (1960), Markov chain with applications (2nd Edition)

STSO 407: STATISTICAL DECISION THEORY

OBJECTIVE:-

- This paper deals with the statistical decision theory.

UNIT–I

Game and Decision Theories: Basic elements of game and Decision; Comparison of the two theories; Decision function and Risk function; Randomization and optimal decision rules; Form of Bayes rules for estimation.

UNIT–II

Main Theorems of Decision Theory: Admissibility and completeness; Fundamental theorems of Game and Decision theories; Admissibility of Bayes rules; Existence of Bayes decision rules; Existence of minimal complete class; Essential completeness of the class of non randomized decision rules; Mini max theorem; The complete class theorem; Methods for finding minimax rules.

UNIT–III

Sufficient Statistics: Sufficient Statistics and essentially complete class of rules based on Sufficient Statistics; Complete Sufficient Statistics; Continuity of the risk function.

UNIT–IV

Invariant Statistical Decision Problems: Invariant decision problems and rules; Admissible and minimax invariant rules; Minimax estimates of location parameter; Minimax estimates for the parameters of normal distribution.

UNIT–V

Multiple Decision problems: Monotone Multiple decision problems; Bayes rules in multiple decision problems; Slippage problems.

Books for Study and Reference:-


STSO 408: ACTUARIAL STATISTICS

OBJECTIVE:-

- This paper deals with full understanding of Actuarial Statistics.

UNIT–I

Accumulated value and present value of a sum under fixed and varying values of interest. Nominal and effective values of interest – Annuity – Classifications of annuities – Present and accumulated values of annuities – Immediate annuity due and deferred annuity.

UNIT–II

Redemption of loans – Redemption of loans by installments payable times in a year Interest being p.a. effective. Role of probability distribution in general insurance (Weibull, Exponential).
UNIT–III

UNIT–IV

UNIT–V

Books for Study and Referene:-
1. Mathematical basis of Life Assurance (IC-81): Published by Insurance Institute of India, Bombay.

STSO 409: BAYESIAN INFERENCE

OBJECTIVE:-
- This paper gives a clear in sight about Bayesian methodology inference and related problems.

UNIT–I

UNIT–II
Concept of prior distribution – Classifications of prior: Informative, Non informative and Restricted classes of priors – Non-informative priors for location and scale problems – Non-informative priors in General settings – Various approach to prior selection.

UNIT–III
Conjugate prior distributions: Sufficient statistics – Construction of the conjugate family- Conjugate families for sample from a Normal distribution – Equivalent prior sample size.

UNIT–IV
Bayes estimation – Bayes estimates for Binomial and Poisson distribution using conjugate priors. Problems of testing hypothesis – Testing a simple hypothesis about the mean of a Normal distribution.

UNIT–V
Testing hypotheses about the mean of a Normal distribution when the precision is unknown, deciding whether a parameter is smaller or larger than a specified value, deciding whether a mean of a Normal distribution is smaller or larger than a specified value.

Books for Study and Reference:-
7. William A Link and Richard J. Barker (2009) Bayesian Inference with ecological applications.

**STSO 410: ADVANCED ECONOMETRICS**

**OBJECTIVE:**
- To enrich the skills of students to get more applied knowledge in Econometrics.

**UNIT–I**

**UNIT–II**
Heteroscedasticity: The nature of heteroscedasticity, OLS Estimation in the presence of heteroscedasticity, the method of generalized least squares (GLS), Consequences, Detection, remedial measures, caution about overreaching to heteroscedasticity.

**UNIT–III**

**UNIT–IV**
Model selection criteria, Types of specification error, consequences of model specification errors, Test of specification of errors, errors of measurements, Model selection criteria.

**UNIT–V**
Simultaneous-Equation Models: The nature, examples of simultaneous equation models. Identification problem, rules for identification, Estimation, ILS, 2SLS, Estimation using LIM, instrumental variables, K-class estimators, FIML, 3SL.

**Books for Study and Reference:**

**STSO 411: TIME SERIES ANALYSIS**

**AIM:** To understand the concepts and applications of Time series analysis techniques.

**UNIT–I**
Forecasting Perspective: An overview of forecasting techniques, the basic steps in forecasting task, Basic forecasting tools: Time series and cross-sectional data, graphical summaries, numerical summaries, Measuring forecast accuracy, predictions intervals, transformations and adjustments.
Time series decomposition: Classical decomposition, STL decomposition, Census Bureau methods, forecasting and decomposition.

UNIT–II

UNIT–III

UNIT–IV

UNIT–V

Books for study and Reference:-