



Annamalai University
DEPARTMENT OF STATISTICS
M.Sc. Statistics (Two Year) Programme
Programme Code: SSTA21

Programme Structure
(For students admitted from the academic year 2019-2020)

REGULATIONS

1. Name of the Programme:

Annamalai University offers a two year M. Sc. Degree Programme (Semester Pattern) in **STATISTICS** with provision for a research project in the second year. The term 'credit' is used to describe the quantum of syllabus for various courses in terms of hours of study. Core courses are a set of compulsory courses required for each programme. The minimum credit requirement for two year Masters Programme in **STATISTICS** is 90.

2. Eligibility for Admission:

A pass in **B.Sc. STATISTICS** degree examination or a pass in **B.Sc MATHEMATICS /B.Sc COMPUTER SCIENCE** degree examination with atleast one course in **STATISTICS**.

3. Duration of the programme:

The two year Programme for the degree of Master of Science in **STATISTICS** shall consists of four Semesters, two Semesters in the first year and two Semesters in the second year.

The academic year shall be divided into two Semesters, the first being from July to November and the second from December to April. The University examinations (end Semester examinations) in the first/third Semester shall be conducted in November and the examinations (end Semester examinations) in the second/fourth Semester in May. A candidate who does not pass the examination in any course(s) of the first, second and third Semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent Semester/year.

4. Course Features:

The programme consists of core courses (CC) and elective courses (EC) distributed among the four Semester periods. The core courses include theory, practical and project work, seminar, project report and viva voce examination.

5. 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.

6. Structure of the Programme:

The Masters Programme will consist of:

- i. Core courses which are compulsory for all students.
- ii. Elective courses which students can choose from amongst the courses offered by the other departments of the same faculty as well as by the departments of other faculties of the University or within the Department.
- iii. Dissertation / Project Work / Practical training / Field work, which can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.

7. Attendance:

Every teaching faculty handling a course shall be responsible for the maintenance of attendance Register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the Semester about the attendance particulars of all students.

Each student should earn 75% attendance in the courses of the particular Semester failing which he or she will not be permitted to sit for the End-Semester Examination. The student has to repeat the Semester in the next year.

8. Examinations:

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

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

Theory	Internal Marks	Practical	Internal Marks
Test-I	15	Test-I	15
Test-II		Test-II	15
Seminar and Assignment	10	Viva and Record	10
Total	25	Total	40

There will be one End Semester Examination with 75% marks for theory and 60% for practical. The pattern of question paper for theory examination is common for the entire faculty and will be decided by the respective faculty.

9. Evaluation of dissertation:

The dissertation shall be evaluated as follows

Internal assessment by the Research supervisor	25	Marks
Valuation of Dissertation	50	Marks
Viva-Voce Examination	25	Marks

10. Marks and Grading:

A 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 minimum of 50 % marks in each course is prescribed for a pass. A student has to secure 50% minimum in the end Semester examination.

If a candidate who has not secured a minimum of 50% marks in a course shall be asked to reappear for the exam for that specific course.

The student can repeat the End Semester Examination when it is offered next in the subsequent Odd / Even Semesters.

11. 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.

Marks	Grade Points	Letter Grade	Class
90 and above	10	S	Exemplary
85-89	9.0	D+++	Distinction
80-84	8.5	D++	Distinction
75-79	8.0	D+	Distinction
70-74	7.5	A+++	First Class
65-69	7.0	A++	First Class
60-64	6.5	A+	First Class
55-59	6.0	B	Second Class
50-54	5.5	C	Second Class
49 or Less		RA	Reappear

The successful candidates are classified as follows.

I – Class 60% marks and above in overall percentage of marks (OPM).

II – Class 50-59% marks in overall percentage of marks.

Candidates who obtain 75% and above but below 89% of marks (OPM) and above 90% (OPM) shall be deemed to have passed the examination in FIRST CLASS with Distinction and exemplary respectively provided he/she passes all the courses prescribed for the programme at the first appearance.

12. Course-Wise Letter Grades:

The percentage of marks obtained by a candidate in a course will be indicated in a letter grade. A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA. A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

A letter grade RA in any course implies a failure in that course. The RA Grade once awarded stays in the grade card of the student and will not be deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even Semester in which the candidate has appeared for clearance of the arrears.

If a student secures RA grade in the Project Work / Field Work / Practical Work / Dissertation, he/she shall improve it and resubmit if it involves only rewriting by incorporating the clarifications as per the suggestions of the evaluators or he/she can re-register and carry out the same in the subsequent Semesters for evaluation.

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19STAC101	Core 1: Linear Algebra and Matrix Theory	4		4	25	75	100
19STAC102	Core 2: Measure and Probability Theory	4		4	25	75	100
19STAC103	Core 3: Sampling Theory	4		4	25	75	100
19STAP104	Core 4: Statistics Practical- I		6	3	40	60	100
19STAP105	Core 5: Statistics Practical- II		6	3	40	60	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
Total Credits							
Semester-II							
19STAC201	Distribution Theory	4		4	25	75	100
19STAC202	Estimation Theory	4		4	25	75	100
19STAC203	Statistical Quality Control and Reliability	4		4	25	75	100
19STAP204	Statistics Practical–III		6	3	40	60	100
19STAP205	Statistics Practical–IV		6	3	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
	Elective 3: Department Elective	3		3	25	75	100
Total Credits							
Semester-III							
19STAC301	Testing of Statistical Hypotheses	4		4	25	75	100
19STAC302	Multivariate Statistical Analysis	4		4	25	75	100
19STAC303	Operations Research	4		4	25	75	100
19STAC304	Programming in R	4		4	25	75	100
19STAP305	Statistics Practical-V		6	3	40	60	100
19STAP306	Statistics Practical-VI		6	3	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Elective 5: Department Elective	3		3	25	75	100
Total Credits							
Semester-IV							
19STAC401	Design and Analysis of Experiments	4		4	25	75	100
19STAC402	Stochastic Processes	4		4	25	75	100
19STAP403	Statistics Practical – VII		6	3	40	60	100
19STAP404	Statistics Practical – VIII		6	3	40	60	100
19STAD405	Project (Dissertation and Viva-Voce/in plant training)		12	6	25	75	100
Total Credits							
Semesters I-IV Total Credits							
Value added Course							
On-line courses (SWAYAM MOOC and NPTEL)							

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.

2. Students may opt for any Value-added Courses listed in the University website.

Elective Courses

Department Electives (DE)

S. No.	Course Code	Course Title	Hours/Week			Marks		
			L	P	C	CIA	ESE	Total
1.	19STAE206.1	Programming with C++	3	0	3	25	75	100
2.	19STAE206.2	Applied Regression Analysis	3	0	3	25	75	100
3.	19STAE307.1	Java and Oracle Programming	3	0	3	25	75	100
4.	19STAE307.2	Advanced Econometrics	3	0	3	25	75	100

Interdepartmental Electives (IDE)

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
19 STSE 215.1	Statistical Methods	3	0	3	25	75	100
19 STSE 215.2	Mathematical Statistics	3	0	3	25	75	100
19 STSE 315.1	Bio Statistics	3	0	3	25	75	100

S. No.	Course Code	Course Title	Department	Hours/Week			Marks		
				L	P	C	CIA	ESE	Total
1.	19 SOSE 115.1	Soft Skills	English	3	0	3	25	75	100
2.	19 MATE 215.1	Discrete Mathematics	Mathematics	3	0	3	25	75	100
3.	19 MATE 215.2	Numerical Methods		3	0	3	25	75	100
4.	19 MATE 315.1	Differential Equations		3	0	3	25	75	100
5.	19 PHYE 215.1	Classical Mechanics and Special Theory of Relativity	Physics	3	0	3	25	75	100
6.	19 PHYE 215.2	Physics of the Earth		3	0	3	25	75	100
7.	19 PHYE 315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
8.	19 PHYE 315.2	Energy Physics		3	0	3	25	75	100
9.	19 CHEE 215.1	Applied Chemistry	Chemistry	3	0	3	25	75	100
10.	19 CHEE 315.1	Basic Chemistry		3	0	3	25	75	100
11.	19 CHEE 315.2	Instrumental Methods of Analysis		3	0	3	25	75	100
12.	19 BOTE 215.1	Plant Tissue Culture		3	0	3	25	75	100

13.	19 BOTE 215.2	Plant Science – I	Botany	3	0	3	25	75	100
14.	19 BOTE 315.1	Gardening and Horticulture		3	0	3	25	75	100
15.	19 BOTE 315.2	Plant Science – II		3	0	3	25	75	100
16.	19 ZOOE 215.1	Animal Culture Techniques	Zoology	3	0	3	25	75	100
17.	19 ZOOE 315.1	Environmental Science		3	0	3	25	75	100
18.	19 GEOE 215.1	Environmental Geosciences	Earth Sciences	3	0	3	25	75	100
19.	19 GEOE 315.1	Applied Geophysics		3	0	3	25	75	100
20.	19 BIOE 215.1	Basic Biochemistry	Biochemistry & Biotechnology	3	0	3	25	75	100
21.	19 BIOE 215.2	Basic Biotechnology		3	0	3	25	75	100
22.	19 BIOE 315.1	Biochemical Techniques		3	0	3	25	75	100
23.	19 BIOE 315.2	Immunology		3	0	3	25	75	100
24.	19 MIBE 315.1	Microbiology	Microbiology	3	0	3	25	75	100
25.	19 CSCE 215.1	R Programming	Computer & Information Science	3	0	3	25	75	100

Value Added Course

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
VAC	Statistical Methods for Data Analysis	3	0	0	25	75	100

Programme Objectives

This Master Degree programme in Statistics (M.Sc., (Statistics)) has been designed according to the latest requirements of statistical data analysis. Initially, it provides a strong mathematical back ground and subsequently the various statistical theory and methods such as probability models, distributions, sampling techniques, estimation methods, hypothesis testing, multivariate techniques of data analyses, statistical quality control, stochastic modeling and optimization techniques are included with latest updation. Further the latest computer languages such as C++, R, Java programming are included and practical sessions are allotted to have training on various statistical softwares that includes SPSS, SAS, SYSTAT, STATGRAPH. The students are well equipped to enable to analyse the data statistically and interpret them with their self confidence.

Programme Outcomes

- PO1: The students will gain knowledge in the concepts of statistical methods and models
- PO2: The students will be trained for data collection on various fields of survey enabling them to classify and analyze them statistically
- PO3: Students will be familiarized in C++ and R programming languages and various statistical softwares
- PO4: The students will be able to solve any problems in data relating to industrial applications to maintain the quality and improvement of the manufactured product
- PO5: The students will be able to formulate any kind of design problems for application in the field of laboratory and agricultural field experiments

Programme Specific Outcomes

At the end of the programme, the student will be able to

- PSO1: Understand mathematical statistical and computer software concepts
- PSO2: Prepare programs using the C++ and R languages
- PSO3: Utilize the appropriate distributions on their problems, applying probability in real life problems and able to estimate the parameters based on the knowledge gained
- PSO4: Apply various multivariate data analyses using statistical softwares
- PSO5: Apply SQC techniques which will be faced in industrial applications
- PSO6: Analyze the data on agriculture field experiments using various types of designs they learned

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	✓	✓		✓			✓			✓		✓	✓			✓		✓	
CO2	✓	✓			✓			✓	✓		✓			✓					✓
CO3	✓	✓		✓	✓					✓		✓	✓	✓		✓		✓	
CO4	✓	✓				✓		✓		✓		✓		✓				✓	✓
CO5	✓	✓	✓				✓			✓		✓			✓	✓	✓		✓
CO6	✓	✓	✓	✓		✓		✓		✓	✓		✓		✓	✓	✓		

Semester-I

19STAC101 – Linear Algebra And Matrix Theory

Credits:4

Hours:4

Learning Objectives: To enrich the skills of students for learning the concepts, methods of matrices and Linear Algebra.

Unit-1

Matrices – Rank and inverse of matrices – properties – Eigen values and Eigenvectors – Idempotent and partitioned matrices- Generalized inverse and its determination – Reduction of matrices into diagonal, echelon, canonical and triangular forms – Quadratic forms – Reduction and classification of quadratic forms – Cochran’s theorem.

Unit-2

Vector Space, Sub-spaces, Basis of a vector space – Vector spaces with inner products – Gram-Schmidt orthogonalization.

Unit-3

Linear transformation (LT) – Properties – Matrix of a linear transformation – Matrix of composite transformation – Matrix of an inverse transformation – Change of basis – Orthogonal transformation – Dual space.

Unit-4

Linear equations – Solution space and null space – Sylvester’s law of nullity – Generalized inverse of a matrix – Moore – Penrose inverse.

Unit-5

Eigen values and eigen vectors of an LT – left eigen vectors, right eigen vectors, Diagonalizable, LT – Lambda matrix, Composition of lambda matrices, Operator polynomial, Cayley-Hamilton theorem and minimal polynomial for an LT – Eigen values of matrix polynomials.

Book for Study and Reference:-

- 1) Shanti Narayan (1976). “A Text Book of Matrices”, S. Chand & Co, New Delhi.
- 2) Richard R. Goldberg (1970). “Methods of Real Analysis”, Oxford & IBH Pub. Co. Pvt. Ltd, New Delhi.
- 3) G. De Barra (1981). “Measure Theory and Integration”, Wiley Eastern Ltd, New Delhi
- 4) Walter Rudin (1986) Real and Complex Analysis (International series in Pure and Applied Mathematics).
- 5) Halsey Royden and Patrick Fitzpatrick (2010) Real Analysis (4th Edition).

Course Outcomes

At the end of the course, the student will be able to

- CO1: Solve problems in matrices and quadratic forms
- CO2: Understand the concepts of vector space
- CO3: Understanding various matrix transformations
- CO4: Solving problems in linear equations
- CO5: Obtain the eigen values and eigen vectors

Semester-I

19STAC102 : Measure And Probability Theory

Credits:4

Hours:4

Learning Objectives: To build a foundation for the measure and applications of Probability Concepts.

Unit-1

Limit Superior, Limit inferior and limit of a sequence of sets – Field and Sigma field - Monotone class – Functions and inverse functions – Borel field – Countable and finitely additive set function – Measurable space – Measure space – Measure, Properties of Measure. Lebesgue – Steiltjes measure – Lebesgue measure. Measurable function, Simple function. Concept of almost everywhere. Approximation theorem (statement only).

Unit-2

Measure Integral – Properties – Monotone convergence theorem – Fatou’s lemma – Dominated convergence theorem (statement only) – Absolute continuity of two measures – Radon-Nykodym theorem (statement only). Product sets and Fubini’s theorem (statement only).

Unit-3

Probability measure – Random variable —distribution function – Expectation – inequalities – Jensen, Basic, Cauchy-Schwartz. Conditional probability - Conditional expectation – Independence of random variables – Borel-Cantelli Lemma – Kolmogorov Zero – one law.

Unit-4

Convergence of random variables – almost sure, in law, in probability, in r th mean and their interrelations – Characteristic function – Inversion formula, Convergence of distribution functions and characteristic functions – Helly-Bray theorem – Continuity theorem.

Unit-5

Law of large numbers – Weak law of large numbers – Kolmogorov's strong law of large numbers – Glivenko – Cantelli Theorem – Central limit theorems – Lindeberg-Cramer - Levy theorem, Liapounov's theorem.

Book for Study and Reference:-

- 1) Bhat, B.R. (1981) Modern Probability Theory, Wiley Eastern, New Delhi.
- 2) De Barra, G. (1987) Measure Theory and Integration, Wiley Eastern, New Delhi.
- 3) Burill, C.W (1972) Measure, Integration and Probability, McGraw Hill, New York.
- 4) Tucker, H.G. (1967) A Graduate Course in Probability, Academic Press, New York.
- 5) Loe've, M. (1955) Probability Theory, D. Van Nostrand, London.
- 6) Munroe, M.E. (1965) Measure and Integration, Addison & Wesley, New York.
- 7) Ash, R.B. (1972) Real Analysis and Probability, Academic Press, New York.
- 8) Billingsley, P. (2012) Probability and Measure, 3/e, Wiley, New York.
- 9) Feller, W. (2008) An Introduction to Probability Theory and Its Applications, Vol. I, 3/e, Wiley, New York.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the various types of measures
- CO2: Study the theorems relating to measures
- CO3: Apply the use of zero one laws
- CO4: Application of theorems on random variables
- CO5: Utilize the law of large numbers in research studies

Semester -I

19STAC103 : Sampling Theory

Credits:4

Hours:4

Learning Objectives: 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-1

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-2

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-3

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.

Unit-4

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-5

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.

Books for Study and Reference:-

1. Daroga singh, and F.S.Chaudhary (1977), Theory and Analysis of sample survey design, New Age International Publishers, New Delhi.
2. Cochran,W.(1984) Sampling Techniques. Wily Eastern.3rd Edition, New York.
3. Murthy, M.N., (1977), Sampling Theory and Methods, Statistical Publishing Society, Kolkatta.
4. Sampath, S. (2005), Sampling theory and methods, Narosa Publishing house.
5. Agarwal Np, Sonia Agarwal (2006), Sampling methods and Hypothesis testing. Rbsa Publishers.
6. Desraj, Promod Chandhok (1998), Sample survey theory, Narosa Publishing house.
7. Parimal Mukhopadhyay(1998)Theory and methods of survey sampling.Prentice Hall of India Pvt. Ltd.
8. Sukhatme & Sukhatme, P.V. (1958), Sampling Theory of Surveys with Applications. The Indian Society of Ag. Statistics, New Delhi.
9. Desraj (1976) Sampling Theory, Tata McGraw Hill, New Delhi.

Course Outcomes

At the end of the course, the student will be able to

CO1: Study the various criteria of estimators

CO2: Understand the concepts of sufficiency and completeness

CO3: Derive different inequalities

CO4: Understand the various methods of estimation and interval estimation

CO5: Study the Bayes estimation

Semester-I

**19STAP104 – Statistics Practical – I
(Calculator Based Practical)**

Credits:3

Hours:6

Learning Objectives: To have practical knowledge on solving problems in matrices, sampling techniques.

Practical Schedule

Matrix Theory

- Arithmetic operations on matrices
- Determinent of matrices
- Solulition of simultaneous equations
- Cramer's rule
- Sweep-out methods
- Inverse of a matrix
- Rank of matrices
- Eigen values and eigen vectors

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.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Operations of matrices using practical applications
- CO2: Problems solving for simultaneous equations
- CO3: Estimation of parameters using sampling techniques

Semester-I	19STAP105 – Statistics Practical – II (Computer Based Practical)	Credits:3 Hours:6
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Learning Objectives: To Gain The Knowledge of Basic Statistical Computation through using SPSS and SIGMAPLOT.

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.

SIGMAPLOT

- Descriptive Statistics: mean, Median, Mode.
- Skewness and Kurtosis
- Correlation and Regression.

Course Outcomes

At the end of the course, the student will be able to

- CO1: familiarize in SPSS and SIGMAPLOT to
- CO2: Calculate the various statistical measures
- CO3: Test the significance of the parameters
- CO4: Apply ANOVA test for appropriate data
- CO5: Analyze the data using various multivariate analyses
- CO6: Draw diagrams and graphs

Semester-I	19 SOSE 115.1 Elective – I IDE 1 Soft Skills	Credits:3 Hours:3
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Learning Objectives: Soft skills evolve the personality of a person and prepare for competition in the changing employment market elsewhere.

Unit-1 Personality Development

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

Unit-2 Effective Listening

Registration of ideas – Crystallization – Listening – What does Listening mean? – Why are people inherently listening? –Poor listening habits- Types of Listening – Effective and Ineffective Listening Skills – Pay – Offs of Effective Listening – Barriers to Listening- Active and Passive Listening.

Unit –3 Interpersonal Communication

Characteristics of Interpersonal Relationships – Intimacy in Interpersonal Relationship – Relationship Development and Maintenance – Self Disclosure in Interpersonal Relational Relationships.

Unit –4 Public Speaking

What is Public speaking – The art of Public Speaking –Language and Proficiency in Public Speaking – Spoken English – Fluency –Awareness of Different Accents – Interviews – Group Discussion – Seminars – Telephone Skills.

Unit-5 Writing Skills

Business writing of Sorts – Common Components of business Letters – strategies for Writing the Body of a Letter- Writing of Order sorts like Memos, Notes etc. – Business Report – Business Proposal.

Books for study and Reference:-

1. Namrata Palta, the Art of effective Communication, Lotus Press, New Delhi, 2007.
2. Ed gar Thorpe, Showick Thrope, Winnning at Intervies, dorling Kindersley (India) Pvt.Ltd, 2006.
3. S.K.Mandal, Effective communication and Public Speaking, Jaico Publising H/ouse, Mumbai, 2005.
4. Lani Aredondo, Communicating Effectively, Tata McGraw- Hill Edition,2003.
5. Robert Bolton , People Skills, Simon & Schuster, 1986.
6. Ronald B. Adler, George Rooman, Understanding Human Communication , Oxford University Press, 2006.
7. Meenakshi Raman, Prakash Singh, Business Communication, Oxford University Press,2006 .
8. Sasikumar.V and Kiranmai Dutt.P, Geetha Rajeevan, Course in Listening and Speaking II , Cambridge University Press, 2007.
9. Date Carnegie, The Leader in You, Pocket Books , New York,1993.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Develop skills of personality development.
- CO2: Understand the effective listening.
- CO3: Communicate interpersonal relationships.
- CO4: Shine in public speaking.
- CO5: Develop writing skills.

Learning Objectives: To know the basic ideas of continuous and truncated distributions and to study the concepts of Bivariate distribution, Non-central t, F and χ^2 and Beta distributions, Order statistics and quadratic forms.

Unit-1

A preamble of basic probability distributions – binomial, Poisson, negative binomial, hypergeometric, multinomial, normal, uniform, gamma, beta. Logarithmic and power series distributions – compound distribution – compound binomial and Poisson distributions – Lognormal distribution – Cauchy distribution.

Unit -2

Truncated distributions – left truncated binomial – left truncated Poisson – left and right truncated Normal distributions – Non central t, χ^2 and F distributions.

Unit -3

Bivariate Normal distributions – M.G.F. – Moments – Distribution of correlation coefficient when population correlation coefficient is equal to zero – Distribution of Regression coefficients.

Unit -4

Distributions of order statistics - median, range and mid-range. Distribution of Quantiles – Sample cumulative distribution function and its properties, Kolmogorov–Smirnov one sample statistic.

Unit -5

Distribution of quadratic forms in normal random variables, their mean and variance, independence of quadratic forms, independence of linear and quadratic forms, Fisher-Cochran's theorem.

Books for Study and Reference:-

- 1) Johnson, N.L. Kemp, A.W. and Kotz, S. (2005) Univariate Discrete Distributions.3/e, Wiley, New York.
- 2) Johnson, N.L.Kotz, S. and Balakrishnan, N. (2004) Continuous Univariate Distributions, Vol. I. Wiley , Singapore.
- 3) Johnson, N.L Kotz, S. and Balakrishnan, N. (2014) Continuous Univariate Distributions, Vol. II.Wiley , Singapore.
- 4) Karian, Z.A. and Dudewicz, E.J. (2011) Handbook of Fitting Statistical Distributions, Chapman & Hall,London.
- 5) Rao, C.R. (2009) Linear Statistical Inference and Its Applications,2/e,Wiley,New York.
- 6) Rohatgi, V.K. and Saleh, A.K.MD.E. (2011) An Introduction to Probability and Statistics, Wiley, New Delhi.
- 7) David, H.A. (1971): Order Statistics, Wiley ,New York.
- 8) Mood A.M Graybill, F.A and Boes, D.C (1974) Introduction to the theory of Statistics, 3rd edition, McGraw Hill Publishing Co. Inc., New York.
- 9) Gibbons , J.D and Subhabrata Chakraborti (2010), Non-parametric Statistical Inference, McGraw Hill
- 10) Parimal Mukhopadhyay (1996), Mathematical Statistics, New Central Book Agency, Pvt. Ltd., Calcutta.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Study the various discrete and continuous distributions
- CO2: Study the various truncated distributions
- CO3: Understand the biivariate distributions
- CO4: Study the distributions of order statistics
- CO5: Understand the distributions of quadratic forms

Learning Objectives: To enhance the methods of diagnosis of statistical estimation of parameters.

Unit -1

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.

Unit -2

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-3

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.

Unit-4

Methods of Estimation: Method of moments, method of maximum likelihood, and its Properties Method of Minimum Chi-square, Method of Least Squares. Concept of Bayesian Estimation, Prior and Posterior Distributions. Problems and Exercises. Interval Estimation : Concept , A general Method of Constructing Confidence Intervals (CIs), and Shortest Confidence Intervals . Problems and Exercises.

Unit-5

Bayesian Estimation: Concept of prior distribution – Classifications of prior: Informative, Non informative and Restricted classes of priors – Non-informative priors for location and scale problems Conjugate prior distributions: Posterior distribution and Estimation.

Books for Study and Reference:-

- 1) Rajagopalan, M and P.Dhanavanthan., Statistical inference, PHI Learning Private Limited, New Delhi, 2012).
- 2) Gibbons, J.D. and S.Chakraborti, Nonparametric Statistical Inference, 3rd ed., Marcel Dekker, 2010.
- 3) Lehman, E.L. and G.Casella, Theory of Point Estimation, 2nd ed., Springer – Verlag, 1998.
- 4) Rao, C.R., Linear Statistical Inference and Its Applications, 2nd ed., Wiley, New York, 1973.
- 5) Zack, S., Parametric Statistical Inference: Basic Theory and Modern Approach, Pergamon Press 1981.
- 6) Zacks, S., The Theory of Statistical inference, John Wiley, New York, 1971.
- 7) Santhakumaran, A (2004), Probability Models and Their Parametric Estimation, K.P.Jam Publication, Chennai.

Course Outcomes

At the end of the course, the student will be able to

CO1: Study the various criteria of estimators

CO2: Understand the concepts of sufficiency and completeness

CO3: Derive different inequalities

CO4: Understand the various methods of estimation and interval estimation

CO5: Study the Bayes estimation

Learning Objectives: To enhance the knowledge of statistical applications in industries.

Unit-1

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 σ charts, np, p, c and u charts, Operating Characteristic curves for control charts.

Unit-2

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-3

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-4

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-5

Concept of reliability, components and systems, coherent systems, reliability of coherent systems. Life distributions, reliability function, hazard rate, Standard life time distribution, Exponential, Weibull, Gamma distributions. Estimation of parameters, IFR and DFR distributions. Reliability of system with independent components. Basic idea of maintainability.

Books for Study and Reference:-

- 1) Douglas C. Montgomery (2005): Introduction to Statistical Quality Control, Sixth edition, John Wiley & Sons, New York.
- 2) Gupta S.C and V.K.Kapoor (2007): Applied Statistics, Sultan Chand Sons, New Delhi.
- 3) Duncan A.J (1959). Quality control and Industrial Management by Duncan A.J. (Richard D.Irwin Inc.USA)
- 4) Leaven worth, R.S. (1964). Statistical Quality Control, (Mc Graw Hill).
- 5) Schilling, E.G. (1982). Advances in acceptance sampling. ASQC Publications, New York.
- 6) Burr, I.W. (1953) Engineering Statistics and Quality Control, McGraw Hill, New Delhi and Sons.
- 7) Mahajan, M (1998): Statistical Quality Control, Dhanpat Rao & Co, New Delhi.
- 8) Biswas S (1996). Statistics of Quality control, Sampling Inspection and Reliability, New Age Intl.
- 9) Bain, L.J and Englehard, M. (1991). Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker.
- 10) Sinha, S.K. (1979), Reliability and Life-Testing, Wiley Eastern, New Delhi.

Course Outcomes

At the end of the course, the student will be able to

- CO1: To draw and obtaining results of various control charts.
 CO2: To study the Cusum, V-mask and moving average control charts.
 CO3: Understanding the concepts of acceptance sampling plans and their functions.
 CO4: Apply the various sampling inspections in real life situations.
 CO5: Understand the various concepts of reliability and their applications.

Semester-II

**19STAP204 : Statistics Practical – III
(Calculator Based Practical)**

Credits:3

Hours:6

Learning Objectives: To have practical knowledge on solving problems in matrices, sampling techniques and estimation of parameters.

Practical Schedule

Estimation

- Unbiased estimator
- Maximum Likelihood Estimation method
- Method of least squares
- Confidence intervals

Statistical Quality Control

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

Operation Research

- Linear Programming Problem – Simplex Method.
- Two Person Zero Sum Games.
- Network – CPM.
- Network – PERT.

Stochastic Processes

- Estimation - TPM
- Stationary Probability
- M/M/1 queueing model

Course Outcomes

At the end of the course, the student will be able to

CO1: Calculate problems relating to estimation methods.

CO2: Construction of various charts in SQC

CO3: Solving problems in operation research by LPP, Game theory and network.

CO4: Solve problems of stochastic processes

Semester-II

**19STAP205 : Statistics Practical – IV
(Computer Based Practical)**

Credits:3

Hours:6

Learning Objectives: To have practical knowledge on solving problems using SYSTAT, STATGRAPH and DBMS.

Practical Schedule

SYSTAT

- Descriptive Statistics.
- Correlation and Regression.
- Chi-Square Test.
- Single mean, Two mean-Z- Test
- Student t-Test: single mean
- Independent two sample
- Pared t-Teat
- ANOVA One-way Classification.
- ANOVA Two-way Classification.

STATGRAPH

Diagrams: Bar, Multiple, Component, Pie diagrams
Graphs: related to Statistical Data.
Q-Q plot and P-P plot
Statistical Applications.

DBMS

Creation of data base file
Use simple command

Course Outcomes

At the end of the course, the student will be able to

- CO1: familiarize in SYSTAT, STATGRAPH and DBMS to
- CO2: Calculate the various statistical measures
- CO3: Test the significance of the parameters
- CO4: Apply ANOVA test for appropriate data
- CO5: Analyze the data using various multivariate analyses
- CO6: Draw diagrams and graphs

Semester-II

19MATE215.2 - Elective– II-IDE-2 Numerical Methods

Credits:3

Hours:3

Learning Objectives: The role of numerical analysis is to develop and analyze the numerical techniques.

Unit-1 Finite Differences and Difference Equations:

Finite difference operator: E-Solution of first and second order linear difference equations with constant coefficients, Non-homogeneous linear difference equations with constant coefficients.

Unit-2 Interpolation, Numerical Differentiation and Integration:

Interpolation, Gregory - Newton forward and backward interpolation formula, Newton's divided difference formula, Lagrange's interpolation formula for unequal intervals, Gauss interpolation formula, Numerical differentiation, Numerical Integration, Trapezoidal rule.

Unit-3 Numerical solution of algebraic and transcendental equations:

Numerical solution of algebraic and transcendental equations, Balzano's bisection method, Successive approximation method, Regula falsi method, Newton Raphson method, Baires method. Numerical solution of simultaneous linear algebraic equations, Gauss elimination method, Gauss-Jordan elimination method, Gauss - Seidel iteration method, Crout's method.

Unit-4 Numerical solution of ordinary differential equation:

Numerical solution of ordinary differential equations of first and second order simultaneous equations, Taylor series method, Euler's method, Improved Euler's method, Modified Euler's method, Runge-Kutta Method of second and fourth order, Milne's Predictor - corrector method – Picard's method.

Unit-5 Numerical solution of partial differential equation:

Numerical solution of partial differential equations, Elliptic equation, Poisson's equation, Laplace equation, Lieberman's iterative method, Relaxation Method, Hyperbolic equations.

Books for Study and Reference:-

1. Numerical methods in Science and Engineering” by M.K. Venkataraman, National Publishing Co., Chennai, 2001.
2. Introductory Methods of Numerical Analysis by S.S. Sastry, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1998.

3. Numerical Methods for Scientists and Engineers by K.Sankara Rao, Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2001.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the problems of numerical algebraic equations.
CO2: Solve problems in linear algebraic equations.
CO3: Understand the various methods of interpolation.
CO4: Understand the various methods of numerical differentiation and integration.
CO5: Solve problems of ordinary differential equations.

ELECTIVE-III – DE-1 19STAE206-1 or 19STAE206-2

Semester-III

19STAC301 : Testing Of Statistical Hypotheses

Credits:4

Hours:4

Learning Objectives: The object is to acquire knowledge on advancements for making decisions based on statistical hypotheses.

Unit-1

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.

Unit-2

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.

Unit-3

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 ($K \geq 1$), Test Consistency, LR Test when Domain of RV Depends on Parameter, Problems and Exercises.

Unit-4

Non-Parametric Methods – Nonparametric Estimation: Empirical Distribution Function, U-statistics. Nonparametric Tests: Single sample Problems, Kolmogorov – Smirnov Test, Sign test, Wilcoxon signed rank test. Two sample Problems: Wald – Wolfowitz run test, Mann-Whitney U-test, K-S two samples Test, Chi-square test, Median test, Kruskal Wallis Test, and Friedman's Test, Problems and Exercises.

Unit-5

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.

Books for Study and Reference:-

- 1) M.Rajagopalan and P.Dhanavanthan., Statistical inference, PHI Learning Private Limited, New Delhi, 2012).
- 2) Gibbons, J.D. and S.Chakraborty, Nonparametric Statistical Inference, 3rd ed., Marcel Dekker, 2010.
- 3) Lehman, E.L. and J.P. Romano, Testing Statistical Hypotheses, 3rd ed., Springer 2005.

- 4) Lehman, E.L. and G.Casella, Theory of Point Estimation, (Springer Texts in Statistics), 2014.
- 5) Rao, C.R., Linear Statistical Inference and Its Applications, 2nd ed., Wiley, New York, 1973.
- 6) J.K. Lindsey (1996), Parametric Statistical Inference (Oxford Science Publications).
- 7) Igor Vajda (1989), Theory of Statistical Inference and Information (Theory and Decision Library B).
- 8) George Casella and Roger L. Berger (2001), Statistical Inference (Springer Texts in Statistics).
- 9) Paul Garthwaite, Ian Jolliffe and Byron Jones (2002). Statistical Inference (Oxford science Publications).

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the various concepts of testing of hypotheses.
 CO2: Study the use of NP lemma and locally most powerful tests.
 CO3: Study the various likelyhood ratio tests.
 CO4: Apply the various non-parametric methods in practical problems.
 CO5: Understand the sequential methods of hypotheses testing.

Semester-III

19STAC302 : Multivariate Statistical Analysis

Credits:4

Hours:4

Learning Objectives: To understand the basic concepts of Multivariate analysis for applying more than two dimension situation.

Unit-1

Multivariate Normal Distribution, Properties, Singular and Non-singular matrices, Marginal and Conditional Distributions. 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.

Unit-2

Generalized T^2 – Statistics: Introduction, derivation of the generalized T^2 – Statistic and its distribution, uses of T^2 – Statistic, confidence region for the mean vector, Two – Sample problem, problem of symmetry, distribution of T^2 under alternative hypothesis optimum properties of the T^2 – test.

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

Unit-3

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-4

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-5

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:-

- 1) T. W. Anderson (1982) – An Introduction to Multivariate Statistical Analysis, (2nd Edition) Wiley, NewDelhi.
- 2) Morison. D. F (1983), Multivariate Statistical methods, Mc Graw Hill 2nd Edition.
- 3) W. R. Dillon and M. Goldstein (1984), Multivariate Analysis methods and Applications, Wiley, New York.
- 4) Johonson. R. A and D. W. Wichern, (1996). Applied Multivariate Statistical Analysis, Wiley, New York.
- 5) Sam Kash Kanchigan (1991). Multiariate Statistical Analysis: A Conceptual Introduction, 2nd Edition.
- 6) Alvin C. Renher (1997). Multivariate Statistical Inference and Applications.
- 7) Wolfgang Karl Hardle and Leopold Simar (2012). Applied Multivariate Statistical Analysis.
- 8) Bryan F.J. Manly (2004). Multivariate Statistical Methods: A Primer, Third Edition.
- 9) Richard A. Johnson and Dean W.Wichen Applied Multivariate Statistical Analysis (5th Edition).
- 10) Alvin C. Rencher and William F. Christensen (2012). Methods of Multivariate Analysis.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the use of multivariate normal tests.
- CO2: Apply the multivariate tests using T^2 statistics.
- CO3: Understand the problems of classification of observations.
- CO4: Apply the multivariate analyses such as principal components, canonical correlations in real life problems.
- CO5: Apply the multivariate analyses such as factorial analysis and cluster analysis in real life problems.

Semester-3

19STAC303 : Operations Research

Credits:4

Hours:4

Learning Objectives: To impart knowledge of various optimization techniques that makes use of statistical concepts abundantly.

Unit-1

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-2

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-3

Theory of games- zero sum two person games; pure and mixed strategies; saddle points; LPP and games; graphical solutions of $2 \times n$ and $m \times 2$ games; dominance property; minimax and maximin and saddle point theorems.

Unit-4

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-5

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:-

- 1) Kanti Swarup, P.K. Gupta and Manmohan (2007) Operations Research, Sultan Chand Sons, New Delhi.
- 2) Cheema, Col.D.S.(2005) Operation Research, Laxmi Publications (P) Lts., New Delhi.
- 3) S.D. Sharma (2002): Operations Research: Kedarnath and Ramnath, Meerut.
- 4) Taha (2005).Operations Research, 8th editioni PHI, New Delhi.
- 5) F.S. Hiller and Liberman (1994): Operations Research, CBS Publishers and Distributions, New Delhi.
- 6) Gass Saul.I (1975).Linear programming methods and applications, 4th edition McGraw Hill, New Delhi.
- 7) Kanti Swarup, P.K. Gupta and Manmohan (2007) Operations Research, Sultan Chand Sons, New Delhi.
- 8) S.D. Sharma (2002): Operations Research: Kedarnath and Ramnath, Meerut.
- 9) J.K.Sharma(2002):Operations Research:Theory and application,Macmillan,India Ltd.
- 10)F.S.Hillier and Liberman (1994): Operations Research, CBS Publishers and Distributions, New Delhi.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the general LPP
- CO2: Apply the integer programming problem.
- CO3: Solve game problems in real life study.
- CO4: Apply CPM/PERT techniques practically.
- CO5: Apply the inventory system in economic problems.

Semester-III

19STAC304: Programming In R

Credits:4

Hours:4

Learning Objectives: To understand the concepts and applications of R Programming Statistics.

Unit-1

Introduction to R – Using the help facility. R data types and objects, reading and writing data import and export. Data structures: vectors, matrices, lists and data frames – Built-in data-Reading data from other sources – Merging data across data sources.

Unit-2

Control structures: functions, scoping rules, dates and times – Grouping, loops and conditional execution – Ordered and unordered factors – Arrays and matrices – Classes and methods – Graphical procedures.

Unit-3

Dealing with Missing values – Data Cleaning and Transforming, Exploring and Visualizing – Writing your own functions – Statistical models in R.

Unit-4

Descriptive statistics – Frequency and contingency tables – correlations – t-tests, Nonparametric tests of group differences: Comparing two groups – Comparing more than two groups.

Unit-5

Distributions and Modeling – Regression – ANOVA – General linear models – Principal component analysis and factor analysis.

Books for study and Reference:-

1. An Introduction to R. Online manual at the R website at <http://cran.r-project.org/manuals.html>.
2. Peter Dalgaard. Introductory Statistics with R(Paperback) 1st Edition Springer-Verlag New York, Inc.
3. Brian Everitt and Torsten Hothorn. A Handbook of Statistical Analysis Using R, 2nd Edition Chapman and Hall/CRC, 2009.
4. Robert Kabacoff, R in Action Data Analysis and Graphic with R, Manning Publications, 2011.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the various basic concepts of R
CO2: Study the various functions and rules of R.
CO3: Understand the data cleaning and transformation.
CO4: Solve problems in statistical methods using R.
CO5: Obtaining inferences for statistical analysis using R.

Semester-III

19STAP305 : Practical – V
(Calculator Based Practical)

Credits:3

Hours:6

Learning Objectives: To familiarise the students in solving problems in testing of hypotheses, non-parametric tests.

Practical Schedule

Testing Of Hypotheses

1. Most powerful test Estimation of power and size.
2. Uniformly MP test – Estimation of power and size.
3. Sequential curve
4. SPRT- OC and ASN curve using binomial, poisson and normal distribution

Non-Parametric Tests

1. Run test
2. One sample Kolmogorov – Smirnov test.
3. Sign test
4. Wilcoxon signed rank test.
5. Mann – Whitney U – test
6. Kolmogorov – Smirnov two sample test.
7. Median test
8. Kruskal – Wallis test.
9. SPRT – OC and ASN curve for Binomial Distribution.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Solve problems in testing of hypotheses.
CO2: Solve problems in non-parametric tests.

Semester-III

19STAP306 – Statistics Practical – VI
(Computer Based Practical)

Credits:3

Hours:6

Learning Objectives: To acquire knowledge of computation of statistics through R software.

Practical Schedule

Programs Using R

- 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.

Course Outcomes

At the end of the course, the student will be able to

CO1: Able to develop programs using R for descriptive statistics.

CO2: Calculate various statistical measures using R

CO3: Analyse and interpret using sample data in R

CO4: Apply various statistical test and interpret using R.

Semester-III

19MATE315.1 - Elective-IV-IDE-3 Differential Equations

Credits:3

Hours:3

Learning Objectives: This course aims to provide logical skills in the formation of differential equations, to expose to different techniques of finding solutions to these equations and in addition stress is laid on the application of these equations in geometrical and physical problems. It also aims to provide logical skills in the formation and solutions techniques of partial differential equations.

Unit-1 Ordinary Differential Equations

Bernoulli Equation – Exact Differential Equations – Equations Reducible to Exact Equations – Equations of First order and Higher degree: Equations solvable for p, Equation solvable for x and Equations Solvable for y – Clairaut's Equation.

Unit-2 Ordinary Differential Equations [Contd...]

Method of Variation of Parameters – 2nd order Differential Equations with Constant Coefficients for finding the P.I.'s of the form $e^{ax} V$, where V is $\sin(mx)$ or $\cos(mx)$ and x^n .

Unit-3 Laplace Transform

Laplace Transform, Inverse Laplace transform, Application to the first and second order linear differential equations.

Unit-4 Partial Differential Equations

Partial differential equations: Formation of P.D.E. by eliminating arbitrary constants and arbitrary functions, Complete, Singular and General integral. Solution of equations of standard types: $f(p,q)=0$, $f(x,p,q)=0$, $f(y,p,q)=0$, $f(z,p,q)=0$, $f(x,p)=f(y,q)$, and Clairaut's form. Lagrange's equation $Pp+Qq=R$, Simple problems.

Unit-5 Series Solution

Series solutions of first order equations, Second order linear equations, Ordinary points, Regular Singular Points

Books for Study and Reference:-

1. Differential Equations, Fourier and Laplace Transforms, by P.R. Vittal, Margham publications, Second Edition, 1999.
2. Differential equations with applications and historical notes by George F. Simmons, Tata McGraw Hill Pub. Co., New Delhi, Second Edition, 2003.
3. Ordinary and partial Differential equations by M.D. Raisinghania and R.S. Aggarwal, Sultan Chand and Company Ltd., 1983.
4. Ordinary and Partial Differential Equations by M.D. Raisinghania, S. Chand, 2006
5. B.S.Grewal [2002] Higher Engineering Mathematics, Khanna Publishers, New Delhi

Course Outcomes

At the end of the course, the student will be able to

CO1: The skill of the formation of differential equations and partial differential equations.

CO2: The skill to expose different techniques of finding solution of differential equations and partial differential equations.

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

Unit-1

Principles of Scientific experimentation; Replication, Randomization and Local control; Various concepts, definitions in experimental designs, Notion of a design matrix, Inter and intra block analysis for general designs models, Orthogonality; connectedness and resolvability.

Unit-2

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 –Analysis of Higher order orthogonal LSD, Analysis of covariance (one concomitant variable) in CRD, RBD.

Unit-3

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.

Unit-4

Factorial Experiments; their needs and advantages, definition of symmetric factorials; meaning of main effects and interactions in 2^n and 3^n experiments; Complete analysis of such Experiments laid out in CRD and RBD. Need and meaning of confounding; total and partial confounding; Construction and analysis of such designs. Split plot design in RBD.

Unit-5

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:-

- 1) Montgomery, D.C. (2005). Design and Analysis of Experiments, Fifth Edition, John Wiley and Sons, New York.
- 2) Robert .O.Kuchi (2000) Design of experiments, statistical principles of research design and analysis 2nd edition, Brooks /wole Publishers.
- 3) Patric J. Wit comband Mark J. Anderson (2000) DOE simplified. Practical tools for effective experimentation, Productivity, Inc.
- 4) Antony, JV (2003) Design of experiments for engineers and scientists, Imprint, Butterworth, Heinemann.
- 5) Das, M.N and Giri. N.C (1986), Design and Analysis of experiments, 2nd Edition, New Age International, New Delhi.
- 6) Federer, W.T. (1967) Experimental Designs – Theory and Applications, Oxford, London.
- 7) Cochran.W.G. and Cox, G.M.(1995). Experimental design. 4th edn Wiley, Nework.
- 8) Kempthorne (1952). The Design and Analysis of Experiments, Wiley, New York.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the various basic concepts of experimental designs.

CO2: Analyse the basic designs and interpretation.

CO3: Apply the various comparison tests and missing observations for experimental data.

CO4: Apply the factorial designs in field experiments.

CO5: Understand the incomplete block designs.

Learning Objectives: To acquire the standard concepts and methods of Stochastic Modelling and applications.

Unit-1

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-2

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-3

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-4

Branching Processes. Discrete time Branching Process. Generating function relation: Mean and Variance of generations – Extinction probabilities and theorems. Renewal processes – renewal function – renewal equation – renewal theorems.

Unit-5

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/1.

Books for Study and Reference:

- 1) Karlin, S and H.W. Taylor (1975) A First course in Stochastic processes, Academic press, 2nd edition
- 2) Karlin, S and H.W. Taylor (1979) A Second course in Stochastic processes, Academic press.
- 3) Prabhu , N.U (1965) Stochastic processes, McMillan
- 4) Bharucha Reid, A.T (1960), Markov chain with applications. John Wiley, New York.
- 5) Chung, K.L (1967) Markov chains with stationary transition probabilities, Springer Verlages, New York, 2nd edition.
- 6) Srinivasan, S.K, Introduction to Stochastic processes and their applicatons.
- 7) Medhi. J (1991), Stochastic processes, New Age International Pvt. Ltd., New Delhi.
- 8) Resnik, (1992) Adventures in Stochastic Processes, Brikauser, Boston
- 9) Grass & Harris , Introduction to Queuing Theory.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the basic concepts and classifications of stochastic processes.
 CO2: Study the theorems of stationary probability distributions.
 CO3: Analyse the birth and death processes and their applications.
 CO4: Study the branching processes and their related concepts.
 CO5: Apply and analyse the various queueing systems in real life situations.

Learning Objectives: To familiarise the students in solving problems in experimental designs and multivariate analysis.

Practical Schedule

Design Of Experiments

- 1) Completely Randomized Design.
- 2) Randomized Block Design.
- 3) Latin Square Design.
- 4) Missing Plot Analysis in CRD, RBD and LSD.
- 5) Multiple Comparison Test – DMRT, LSD and CD.
- 6) 2^2 - Factorial Experiment .
- 7) 2^3 - Factorial experiment with complete confounding.
- 8) 2^3 - Factorial experiment with partial confounding.
- 9) 3^2 - Factorial Experiment.

Multivariate Analysis

- 1) Estimation of Mean vector and Covariance Matrix.
- 2) Test for the Mean vector when Covariance Matrix is known.
- 3) Test for Equality of Mean vector.
- 4) Test for the Mean vector when Covariance Matrix is unknown.
- 5) Test for Covariance Matrix.
- 6) Test for Equality Covariance Matrices.

Course Outcomes

At the end of the course, the student will be able to

CO1: Carryout the analyses for various experimental designs and interpretation.

CO2: Apply the multivariate statistical tests.

Semester-IV

**19STAP404 : Practical – VIII
(Computer Based Practical)**

**Credits:3
Hours:6**

Learning Objectives: To familiarise the students in solving problems in using C++.

Practical Schedule

Programs Using C++

- Programs for mean and standard deviation
- Correlation coefficient
- 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.
- Analysis of variance One-way Classification.
- Addition and Subtraction of Matrices.

Course Outcomes

At the end of the course, the student will be able to

CO1: Prepare programs for various statistical measures .

- CO2: Prepare programs for various statistical tests.
CO3: Prepare programs for various matrix problems

DEPARTMENT ELECTIVE COURSES

19STAE206-1 Programming With C++

Credits:3

Hours:3

Learning 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-1

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

Unit-2

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 arguments, Storage class specifier, Recursive function, Pre-processors, Header files and standard function.

Unit-3

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-4

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

Unit-5

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:-

1. Ravichandran, D. (2003). Programming with C++: Tata Mc Graw Hill Publications, Company Limited, 2nd Edition.
2. Balagurusamy, E. (2006). Programming with C++: Tata Mc Graw Hill Publications, Company Limited, 3rd Edition.
3. Eric Nagler, (1999) Learning C++ Second Edition, PWS Publishing co., Ltd., 3rd Edition, 2003
4. Robert Lafore, (2002). Object oriented programming in C++, Galgotia Pub. Pvt. Ltd, NewDelhi, 4th Edition.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the fundamental concepts of C++ programming
CO2: Understand the various statements of C++
CO3: Study the arrays and pointers in C++
CO4: Familiarize in structures, classes and objects of C ++
CO5: Write programs using C++

19STAE206-2 Applied Regression Analysis

Credits:3

Hours:3

Learning Objectives : To study the various regression models and their applications.

Unit-1

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-2

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-3

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-4

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-5

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:-

1. Draper N. R and Smith. H (1981), Applied Regression Analysis, John Wiley & Sons.
2. D.N. Gujarati and Sangeetha (2008) Basic Econometrics, (4th Edition). Tata Mc Graw Hill publishing Company, New Delhi.
3. Brook. R. J and Arnold. G. C (1985), Applied Regression Analysis and Experimental Design, Marcel Dekker, Inc.
4. Plackeff. R. L (1960), Principles of Regression Analysis, Oxford at the Clarendon press.
5. Huang. D. S (1970), Regression and Econometric Methods, John Wiley and Sons.

19STAE307-1 Java And Oracle Programming

Credits:3

Hours:3

Learning Objectives: To understand the concepts and preparing programs using JAVA and also highlights the concept of ORACLE and its functions.

Unit-1

Introduction to JAVA, Data types, variables and arrays, control statements, looping statements. Classes, Methods, Data structures, Inheritance, packages and Inheritance. Exception handling, Multispread programming, I/O classes, String Handling, Utility classes and file stream.

Unit-2

Applet class – introduction to Abstract Windows Toolkit (AWT) – working with windows, Graphics and Test – AWT controls, Layout Managers, Images, Animations, Swing class library. Networking: Using connection less service connection oriented service utility package.

Unit-3

Introduction: Purpose of data base systems – Overall system structure. Entity Relationship model: Entity and Entity sets – Relationships – E.R. diagram. Basic concepts of database: recovery, concurrency control, database security and Integrity. Relational model: Structure of

relational database – relational algebra. Relational data base design: Pitfalls in relational database design – Normalization using Functional dependencies.

Unit-4

Oracle's PL/SQL: Variables in PL/SQL – The other variables – dynamic data types – strings; Statements; Control Statements – If-Then-Endif-The Else – Elseif – For loop – The While loop – loops and labels – scoping. Oracle Forms: SQL forms – Generating a forms – Parent Child co-ordination – Retrieving multiple data – data entry – data types – Field characteristics – Automatic generation of a form – The enforce Key – Triggers – procedures.

Unit-5

Oracle menus: Securing the application Zoom in and out – Display no privilege – Sub menus – Oracle Report: Developing a report – The Reset group – The report setting – Parent Child queries.

Book for Study and Reference:

- 1) C. Xavier, (2002) Projects on JAVA, Scitech Publications (India) Pvt. Ltd., Chennai – 17.
- 2) Patrick Naughton and Herbert Schildf (2001). The complete Reference Java 2.0, TMH Publishing Company Ltd., 4th edn. New Delhi.
- 3) Margaret Levine Yound,(1999) "Internet: The Complete Reference", Tata McGraw Hill Publishing Company Limited, New Delhi, Millennium Edition.
- 4) Douglas E. Comer, (1999) "The Internet", 2nd Edition, PHI, New Delhi.
- 5) Khandara, S.S. (2002) programming in JAVA, S.CHAND & Company Limited 1st Edition, New Delhi.

19STAE307-2 Advanced Econometrics

Credits:3

Hours:3

Learning Objectives: To enrich the skills of students to get more applied knowledge in Econometrics.

Unit-1

Nature and Scope of Econometrics. Normal linear Regression Model: Probability disturbances of error term, Normality Assumption, Properties of OLS estimator under Normality assumption, Method of Maximum likelihood, MLE of two variables regression model. Multicollinearity: The Nature, Estimation in the presence of Multicollinearity, Consequences of Multicollinearity, Detection of Multicollinearity, Remedial measures.

Unit-2

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 heteroscedasity.

Unit-3

Autocorrelation: The nature, OLS estimation in the presence of autocorrelation, BLUE estimation in the presence of autocorrelation, consequence of auto correlation. Detecting autocorrelation, remedial measures. Correcting for autocorrelation, method of GLS, Newey-West method of correcting of OLS standard error. Other aspects of autocorrelation, ARCH, GARCH models.

Unit-4

Model selection criteria, Types of specification error, consequences of model specification errors, Test of specification of errors, errors of measurements, Model selection criteria.

Unit-5

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:-

- 1) Gujarati D.N and Sangeetha (2007) Basic Econometrics, McGraw- Hill co, New York.
- 2) Johnston (1984) – Econometric Methods, McGraw- Hill, 3rd Ed, New York.
- 3) James H. Stock and Mark W. Watson (2010) Introduction to Econometrics (3rd Edition) (Addison-Wesley Series in Economics).
- 4) James H. Stock and Mark W. Watson (2006) Introduction to Econometrics (2nd Edition) (Addison-Wesley Series in Economics).
- 5) Ronald J. Wonnacott and Thomas H. Wonnacott (1979) Econometrics (Wiley Series in Probability and Statistics – Applied Probability and Statistics Section).

Inter Department Elective Course

19STSE215.1 – Statistical Methods

Credits:3

Hours:3

Learning Objectives: To enable the students of other discipline to understand the basic concepts of statistical methods.

Unit-1

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-2

Measures of Central tendency – Mean, Median and Mode and their practical usages. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance and Coefficient of Variation. Measures of Skewness – Pearson's, Bowley's method. Applications of Binomial and Normal distributions.

Unit-3

Measure of Bivariate data – Simple, Partial and Multiple Correlation. Scatter diagram, Pearsons method and Rank correlation method. Regression and their equations – Prediction. Basic concept of Sampling – Parameter and Statistics – Sampling distribution and Standard Error – Simple random sampling and stratified random sampling.

Unit-4

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.

Unit- 5

Chi square test for goodness of fit and independence of attributes. F-test – Analysis of variance, Assumptions, Applications, one way anova and two way anova classifications.

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

Books for Study and References:

- 1) Gupta, S.P. (2011) Statistical Methods, Sultan Chand & Sons, Pvt. Ltd, New Delhi
- 2) Gupta, S.C and V.K. Kapoor, (2011) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Pvt. Ltd, New Delhi
- 3) Darren George, Paul Mallery (2011) SPSS for Windows, 10th Edition, PEARSON

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the various diagrams and graphs for statistical data.

CO2: Calculate the various statistical methods.

- CO3: Calculate the measures for bivariate data.
 CO4: Understand the use of tests of significance.
 CO5: Understand the use of chi square and anova tests.

19STSE215.2 - Mathematical Statistics

Credits:3

Hours:3

Learning Objectives: To impart basic knowledge about random variables and various distributions.

Unit-1

Random Variables and Distribution Functions- Introduction, Properties of Distribution Function, Discrete Random variable-Probability Mass Function, Discrete Distribution Function, Continuous Random variable - Probability density function, Various Measures of Central Tendency, Dispersion, Skewness and Kurtosis for Continuous Probability Distributions, Continuous Distribution Function, Two Dimensional Random Variables- Two dimensional or JPMF, Two dimensional Distribution Functions, Joint Density Function, Marginal Density Function, The Conditional Distribution Function and Conditional Probability Density Function, Stochastic Independence, Problems and Exercises. (Content as in Chapter-5 of Book 1)

Unit-2

Mathematical Expectation- Introduction, Mathematical Expectation or Expected Value of A Random Variable, Expected Value of Function of a Random Variable, Properties of Expectation - Addition Theorem of Expectation, Multiplication Theorem of Expectation, Properties of Variance, Covariance - Variance of Linear combination of Random Variables, Some Inequalities Involving Expectation, Moment of Bivariate Probability Distributions, Conditional Expectation and Conditional Variance, Problems and Exercises.(Content as in Chapter-6 of Book 1)

Unit-3

Generating Functions – Moment Generating Function- Limitations, Properties, Uniqueness Theorem, Cumulants - Properties, Characteristic Function- Properties of Characteristic Function, Necessary and Sufficient Conditions for a Function $\phi(t)$ to be Characteristic Function, Some Important properties – Inversion Theorem, Uniqueness Theorem of Characteristic Functions, Problems and Exercises. (Content as in Chapter-7 of Book 1)

Unit-4

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

Unit-5

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

Books for Study and Reference:-

- 1) Gupta S.G and Kapoor.V.K 'Fundamentals of Mathematical Statistics' Sultan Chand & Sons.
- 2) Mood, A.M,F.A Graybill and D.C Boes (1974), Introduction to the Theory of Statistics, 3rd Edn.McGraw Hill.
- 3) Wilks, S.S.(1983) , Mathematical Statistics, Wiley.
- 4) Rao, c.R (1983), Linear Statistical Inference and its applications, 2nd Edn, Wiley Eastern.
- 5) Johnson and Kotz, (2002) Continuous Univariate Distributions-1, John Wiley and Sons.
- 6) Johnson and Kotz, (2002) Continuous Univariate Distributions-2, John Wiley and Sons.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understanding concepts random variables and probability distributions.
 CO2: Study the expectation and related results.

- CO3: Apply the use of various functions.
CO4: Understand the various descriptive distributions.
CO5: Understand the various continuous distributions.

19STSE315.1 – Bio Statistics

Credits:3

Hours:3

Learning Objectives: To enable the students of other discipline to understand the basic concepts of Bio statistics in Biological applications.

Unit–1

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–2

Measures of Central tendency – Mean, Median and Mode and their practical usages. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance and Coefficient of Variation. Measures of Skewness – Pearson's, Bowley's method. Applications of Binomial and Normal distributions. Applications to Biological Studies.

Unit–3

Measure of Bivariate data – Simple, Partial and Multiple Correlation. Scatter diagram, Pearsons method and Rank correlation method. Regression and their equations – Prediction. Basic concept of Sampling – Parameter and Statistics – Sampling distribution and Standard Error – Simple random sampling and stratified random sampling. Applications to Biological studies.

Unit–4

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. Applications to Biometric experiments.

Unit–5

Chi square test for goodness of fit and independence of attributes. F-test – Analysis of variance, Assumptions, Applications, one way anova and two way anova classifications. Applications to Clinical experiments.

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

Books for Study and References:

- 1) Gupta, S.P. (2011) Statistical Methods, Sultan Chand & Sons, Pvt. Ltd, New Delhi
- 2) Gupta, S.C and V.K. Kapoor, (2011) Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Pvt. Ltd, New Delhi
- 3) Darren George, Paul Mallery (2011) SPSS for Windows, 10th Edition, PEARSON

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the various diagrams and graphs for statistical data.
CO2: Calculate the various statistical methods.
CO3: Calculate the measures for bivariate data.
CO4: Understand the use of tests of significance.
CO5: Understand the use of chi square and anova tests.

Value Added Course For Inter Disciplinary Students

VAC - Statistical Methods For Data Analysis

Learning Objectives : To enlight the students to acquire skills for adopting statistical tools and techniques of data analysis.

Unit–1

Tests of significance- population and sample; parameter and statistic standard error and sampling distribution of a statistic; Utility of Standard error; Steps involved in any test of significance; Basic concepts; Large sample tests- Tests for mean and difference of means; single proportion and equality of proportions; difference of standard deviations ; testing the correlation coefficient; equality of two correlation coefficients.

Unit-2

Exact tests- Test for mean; equality of means and for paired samples; observed partial and multiple correlation and regression coefficients; test for one population variance and test for equality of two population variances; test for observed sample correlation ratio.

Unit-3

Chi-square test for goodness of fit- contingency tables; test for independence of attributes; Yate's correction for contingency table; Bartlett's test for homogeneity of several population variances; test for homogeneity of several population proportions.

Unit-4

Multiple regressions- interpretation of R^2 ; interpretation of partial regression coefficients; test for linearity of regression; test for intercept in a regression. Application of Multivariate tests- Test for population mean vector (for covariance matrix known and unknown). Test for equality of two population mean vectors when the covariance matrices are equal; (known and unknown) Mahalanobis D^2 test.

Unit-5

Non parametric methods; Advantages and disadvantages over parametric methods. Sign test for medians, Median test for two populations, Wald-Wolfowitz run test, Kruskal-Wallis Rank sum Test (H-Test), Mann-Whitney- Wilcoxon rank sum test, U-test, Kolmogorov – Smirnov, Test for goodness of fit, Test for comparing two populations, Test for randomness, Friedman's test.

Book for Study and Reference :-

- 1) Ostle. B and Mensing R. W (1975), Statistics in Research, Third Edition, Oxford & IBH Publishes Co.,
- 2) Gupta S. C. and V. K. Kapoor (2007), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- 3) Norma Gilbert (1981), Statistics, Saunders College publishing.
- 4) Rajagopalan V. (2006). Selected Statistical Tests, New Age International Publishers (P) Ltd., NewDelhi.
- 5) Croxton, E. F and Cowden, D. J (1985), Statistics Practical Business Statistics, Prentice – Hall Inc.
- 6) Catelcult. R (1982), Statistics in Research and Development, Chapman and Hall.
- 7) Medhi. J (1992), Statistical methods, Wiley Eastern Ltd.

Course Outcomes

At the end of the course, the student will be able to

- CO1: Understand the various concepts of statistical tests and to apply large sample tests.
- CO2: Apply the exact tests for research problems.
- CO3: Apply the various chi-square tests .
- CO4: Apply the multiple regression analysis and multivariate tests for real life problems.
- CO5: Apply the non-parametric tests for sample data.