



Bachelor of Science (Honours) Statistics under CBCS

PATNA UNIVERSITY, PATNA

Programme Code:

Programme Outcomes

At the completion of the programme, students will attain the ability to:

PO1: Examine various hypotheses involved, and identify and consult relevant resources to find their rational answers.

PO2: Develop capability to identify logical flaws and loopholes in the arguments of practicing Statisticians, analyse and synthesize data from a variety of sources and accordingly draw conclusions

PO3: Develop original thinking for formulating new problems and providing their solutions

PO4: Develop effective and confident Communication skill after completion of the course.

Programme Specific Outcomes

At the completion of the programme, students will attain the ability to:

PSO1: Demonstrate an application of statistical tools and techniques in almost all fields which are indispensable for people working in fields like agriculture, business, management, economics, finance insurance, education, biotechnology and medical science, etc.

PSO2: Demonstrate the diverse knowledge of statistical techniques for pursuing higher studies

PSO3: Apply statistical tests judiciously to a variety of data sets to arrive at some valid conclusion

PSO4: Examine basic statistical issues in a more logical and methodical manner.

Course Structure

Semester – I

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Descriptive Statistics & Theory of Attributes (Th)	CC-1 (Th)	4-1-0	4	100
2	Descriptive Statistics & Theory of Attributes (P)	CC-1 (P)	0-0-6	2	100
3	Calculus of Finite Differences(Th)	CC-2 (Th)	4-1-0	4	100
4	Calculus of Finite Differences(P)	CC-2 (p)	0-0-6	2	100
5	English Communication	AECC- 1	2-1-0	2	100
6	Generic Elective- 1 (Th)	GE- 1 (Th)	4-1-0	4	100
7	Generic Elective- 1 (P)	GE- 1 (P)	0-0-6	2	100
Total credit - 20					

Semester – II

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Probability Theory & Probability Distribution (Th)	CC-3 (Th)	4-1-0	4	100
2	Probability Theory & Probability Distribution (P)	CC-3 (P)	0-0-6	2	100
3	Integral Calculus and Matrices (Th)	CC-4 (Th)	6-1-0	6	100
4	Environmental Science	AECC- 2	2-1-0	2	100
5	Generic Elective- 2 (Th)	GE- 2 (Th)	4-1-0	4	100
6	Generic Elective- 2 (P)	GE- 2 (P)	0-0-6	2	100
Total credit - 20					

Semester – III

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Sampling Distribution & Tests of Significance (Th)	CC-5 (Th)	4-1-0	4	100
2	Sampling Distribution & Tests of Significance(P)	CC-5 (P)	0-0-4	2	100
3	Survey Sampling & Indian Official Statistics (Th)	CC-6 (Th)	4-1-0	4	100
4	Survey Sampling & Indian Official Statistics (P)	CC-6 (P)	0-0-4	2	100
5	Mathematical Analysis (Th)	CC-7 (Th)	6-1-0	6	100
6	Skill Enhancement Course- 1	SEC- 1	2-1-0	2	100
7	Generic Elective- 3 (Th)	GE- 3 (Th)	4-1-0	4	100
8	Generic Elective- 3 (P)	GE- 3 (P)	0-0-4	2	100
Total credit - 26					

Semester – IV

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Advanced Statistical Inference (Th)	CC-8 (Th)	4-1-0	4	100
2	Advanced Statistical Inference(P)	CC-8(P)	0-0-4	2	100
3	Linear Models (Th)	CC-9(Th)	6-1-0	6	100
4	Statistical Quality Control (Th)	CC-10(Th)	4-1-0	4	100
5	Statistical Quality Control (P)	CC-10(P)	0-0-4	2	100
6	Skill Enhancement Course- 2	SEC- 2	2-1-0	2	100
7	Generic Elective- 4 (Th)	GE- 4(Th)	4-1-0	4	100
8	Generic Elective- 4 (P)	GE- 4(P)	0-0-4	2	100
Total credit - 26					

Semester – V

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Statistical Computing Using C/C++ Programming (Th)	CC-11 (Th)	4-1-0	4	100
2	Statistical Computing Using C/C++ Programming (P)	CC-11 (P)	0-0-4	2	100
3	Time series Analysis (Th)	CC-12 (Th)	4-1-0	4	100
4	Time series Analysis (P)	CC-12 (P)	0-0-4	2	100
5	Discipline Specific Elective- 1	DSE- 1	6-1-0	6	100
6	Discipline Specific Elective- 2	DSE- 2	6-1-0	6	100
Total credit - 24					

Semester – VI

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Design of Experiments (Th)	CC-13 (Th)	4-1-0	4	100
2	Design of Experiments (P)	CC-13 (P)	0-0-4	2	100
3	Multivariate Analysis & Non Parametric Methods (Th)	CC-14 (Th)	4-1-0	4	100
4	Multivariate Analysis & Non Parametric Methods (P)	CC-14 (P)	0-0-4	2	100
5	Discipline Specific Elective- 3	DSE- 3	6-1-0	6	100
6	Project/Dissertation	DSE- 4	0-0-6	6	100
Total credit - 24					

Total Credits – 140***L/T/P: number of classes per week****DSE/GE may either carry 6 credit, i.e., *Theory (4 credit) + Practical (2 credit) format*****Or*****Consolidated (6 credit) for Theory onl***

Discipline Specific Elective Course (DSE):

Course name	L-T-P
1. Operations Research	4-1-4
2. Stochastic Processes & Queuing Theory	5-1-0
3. Econometrics	5-1-0
4. Demography and Vital Statistics	4-1-0
5. Financial Statistics	5-1-0
6. Survival Analysis & Bio Statistics	5-1-0
7. Research Methodology	5-1-0
8. Actuarial Statistics	5-1-0
9. Statistical Data Analysis using 'R'	5-1-0

General Elective (GE):

For Statistics Students		For Other Students	
Course name	L-T-P	Course name	L-T-P
Physics		1.Statistical Method.	4-1-6
Chemistry		2.Introductory Probability.	5-1-0
Botany		3.Statistical interference.	4-1-6
Zoology		4.Applied Statistics.	4-1-6
Mathematics			
Geology			

Skill Enhancement courses (SEC):

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SEMESTER – I

CC1 : DESCRIPTIVE STATISTICS & THEORY OF ATTRIBUTES

Course Outcomes

After the completion of the course, the students will be able to:

- CO1:** Understand the statistical data, types of data, tabular and graphical presentation of data, scales of measurement, measures of central tendency, measures of dispersion, moments, Skewness and Kurtosis, Coefficient of variation,
- CO2:** Comprehend the Correlation (Simple, Multiple and Partial), Rank Correlation, Intra-class correlation etc.
- CO3:** Apply regression analysis, principle of least squares and fitting of different polynomials and exponential curves.

CO4: Understand the consistency of data and independence of attributes, measures of association of attributes.

CC1 : DESCRIPTIVE STATISTICS & THEORY OF ATTRIBUTES (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, consistency and independence of data with special reference to attributes. Scales of measurement- nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical, including histogram and ogives.	14
2	Measures of Central Tendency: mathematical and positional, their relative merits and demerits Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.	10
3	Bivariate data: Definition, scatter diagram, Karl Pearson product moment correlation coefficient and its properties, rank correlation, partial and multiple correlation (3 variables only). Simple linear regression, properties of regression coefficients, principle of least squares and fitting of polynomials and exponential curves.	14
4	Theory of Attributes: Notations, Dichotomy, Classes & class frequency consistency of data and its conditions of independence of attributes criterion of independence, Association of attributes, Yule's coefficient of association, coefficient of colligation.	10
TOTAL		48

Suggested Reading :

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor
5. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor

CC1 : DESCRIPTIVE STATISTICS & THEORY OF ATTRIBUTES (Practical) (02 credits)
<p>Practical</p> <ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-1Th.) ▪ Based on Unit 2 (CC-1Th.) ▪ Based on Unit 3 (CC-1Th.) ▪ Based on Unit 4 (CC-1Th.) <p>USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

CC2 : Calculus of Finite Differences

Course Outcomes

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

- CO1:** Understand the fundamental concepts of functions with several variables, its derivatives in partial form with other important related concepts, their applications in maxima - minima problems.
- CO2:** Apply the principles of integral to solve a variety of practical problems in science and different fields.
- CO3:** Recognize Ordinary Differential Equations (ODEs) and system of ODEs concepts that are encountered in the real world, understand and able to communicate the underlying mathematics involved helping another person gain insight into the situation.

CO4: Distinguish between linear, nonlinear, partial and ordinary differential equations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study and conversation on topics involving differential equations with colleagues in the field of mathematics and sciences.

CC2 : Calculus of Finite Differences (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Finite Difference Table , Forward Difference Operation Δ , The shift Operator E, Properties of Operator Δ and E, Fundamental Theorem of Finite Differences, Relation between E and D , where $D = d/dx$, Missing Terms (Equal Intervals), Factorial Notation. Assumptions of Interpolation, Uses of Interpolation. Method of Parabolic Curve Fitting, Gregory Newton's Forward Interpolation Formula for Equal Intervals, Gregory Newton's Backward Interpolation Formula for Equal Intervals,	14
2	INTERPOLATION WITH ARGUMENTS AT UNEQUAL INTERVALS Divided Differences Δ , Divided Differences Table, Theorems on divided Differences, Newton's Divided Difference formula, Lagrange's Interpolation Formula, Sheppard's Rule.	10
3	Central Difference interpolation Formulae, Gauss's Interpolation Formula, Stirling Formula, Bessel's Formula.	14
4	General Quadrature Formula for Equidistant Ordinates, Trapezoidal Rule, Simps Rule, Simpson's Three- eight Rule, Wedel's Rule.	10
	TOTAL	48

Suggested Reading :

1. Saxena, H. C. : Calculus of finite differences.
2. Freeman H. : Finite differences for Acturial Students Cambridge University, Press
3. Sastery SS : Introductory Methods of Numerical Analysis, Prentice Hall of India
4. Scarborough JB – Numerical Mathematical Analysis Oxford & IBH

CC2 : Calculus of Finite Differences (Practical) (02 credit)	
Practical	<ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-2Th.) ▪ Based on Unit 2 (CC-2Th.) ▪ Based on Unit 3 (CC-2Th.) ▪ Based on Unit 4 (CC-2Th.) <p>USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

SEMESTER- II

CC3 : PROBABILITY THEORY AND PROBABILITY DISTRIBUTIONS

Course Outcomes

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

- CO1:** Understand the probability as a measure of uncertainty of various phenomena.
- CO2:** Comprehend the Random Variables, their uses in marginal and conditional and conditional p.m.f. , p.d.f., c.d.f. etc.
- CO3:** Application as of probability theory in univariate and bivariate random variables with suitable theorems.
- CO4:** Understand different probability distributions with their properties.

CC3 : PROBABILITY THEORY AND PROBABILITY DISTRIBUTIONS (Th) (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic., laws of addition and multiplication, independence and mutual independence of events, theorem of total probability, conditional probability, Bayes' theorem and its applications.	10
2	Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables, bivariate transformations with illustrations.	12
3	Mathematical Expectation and Generating Functions: Expectation of univariate and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.	12
4	Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, Cauchy, beta and gamma along with their properties and limiting/approximation cases.	14
TOTAL		48

Suggested Reading :

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
4. Fundamentals of Mathematical Statistics , S. C. Gupta & V.K. Kapoor
5. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

CC3 : PROBABILITY THEORY AND PROBABILITY DISTRIBUTIONS (Practical) (Practical: 2 credits)
<p>Practical</p> <ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-3Th.) ▪ Based on Unit 2 (CC-3Th.) ▪ Based on Unit 3 (CC-3Th.) ▪ Based on Unit 4 (CC-3Th.) <p>USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

CC4 : INTEGRAL CALCULUS & MATRICES

Course Outcomes

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

CO1: Develop knowledge of basic concepts of the linear algebra

CO 2: Linear Algebra plays an important role to solve problem in applied mathematics.

CO 3: Understand all the concepts of linear algebra and matrices.

CO4: Apply the methods taught in Problem arising out in further studies.

CC4 : INTEGRAL CALCULUS & MATRICES (Theory: 6credits)		
Unit	Topics to be covered	No. of Lectures
1	Integration of rational and irrational functions. Integration by substitution, by parts, partial fractions. Evaluation of definite integral. Special integrals, differentiation and integration under the sign of integration.	12
2	Definite integrals at limit of the sum, Remann integral, integrability of continuous and monotonic functions, Rolle's theorem, Lagrange and cauchy Mean Value theorems.	12
3	Curve tracing, evaluation of double integral, change of order of integration, transformation of variables. Beta and Gamma functions (convergence of Beta and Gamma functions are excluded), their properties, duplication formula, inter-relation.	12
4	Different types of Matrices. Algebra of Matrices. Adjoint and inverse of a Matrix, different ways of finding inverse, partitioning, characteristic equation and Calay-Hamilton theorem.	10
5	Elementary row and column operations. Elementary matrices, equivalent matrices, rank of a matrix, invariance of rank through elementary row/column operations, rank of sum and product of matrices and related theorems. Solution of a system of linear equations via matrix method, consistency, inconsistency conditions.	14
TOTAL		60

Suggested Reading :

1. Calculus – G B Thomas & R L Finney.
2. Integral Calculus – Das & Mukherjee.
3. Integral Calculus – Lalji Prasad.
4. Matrices – Shanti Narayan.
5. Matrices – A R Vashishtha.

SEMESTER – III

CC5 : SAMPLING DISTRIBUTIONS AND TESTS OF SIGNIFICANCE

Course Outcomes

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

- CO1:** Understand the basic concepts of statistics and parameters.
CO2: Understand the distribution of sample mean, median and range,
CO3: Understand the distribution of order statistics, law of large numbers and central limit theorem.
CO4: Understand the derivation of various exact sampling distributions like t, F and chi-square.

CC5 : SAMPLING DISTRIBUTIONS AND TESTS OF SIGNIFICANCE (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Chebyshev's inequality, W.L.L.N., and their applications, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof).	12
2	Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.	12

3	Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 using m.g.f., mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.	12
4	Exact sampling distributions: Student's and Fishers t-distribution, Derivation of its p.d.f., mean, variance, moments and limiting form of t distribution. Snedecore's F-distribution: Derivation of p.d.f., mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.	12
	TOTAL	48

Suggested Reading :

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
6. Fundamentals of Mathematical Statistics , S. C. Gupta & V.K. Kapoor

CC5 : SAMPLING DISTRIBUTIONS AND TESTS OF SIGNIFICANCE (Practical) (Practical: 2 credits)
Practical <ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-5Th.) ▪ Based on Unit 2 (CC-5Th.) ▪ Based on Unit 3 (CC-5Th.) ▪ Based on Unit 4 (CC-5Th.) <p style="text-align: center;">USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

CC6 : SURVEY SAMPLING & INDIAN OFFICIAL STATISTICS

Course Outcomes

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

- CO1:** Understand the principal steps in sample survey, basic principle of sample survey, errors in sampling, complete enumeration versus sampling, simple random sampling with and without replacement, procedure of selecting a sample and determination of sample size.
- CO2:** Know the concept of stratified random sampling, proportional and optimum allocations and their comparisons with SRS, practical difficulties in allocation, estimation of gain in precision, systematic sampling.
- CO3:** Know about ratio, product and regression method of estimation, cluster sampling for equal clusters, two-stage sampling.
- CO4:** Know about Official Statistical System in India through MoSPI, CSO, NSSO, National Statistical Commission and Government of India's Principal publications.

CC6 : SURVEY SAMPLING & INDIAN OFFICIAL STATISTICS (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.	8

2	Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance.	10
3	Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=nk$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.	10
4	Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters). Relative efficiency of cluster sampling with SRS in terms of intra class correlation. Concept of sub sampling.	20
TOTAL		48

Suggested Reading :

1. Cochran W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P. V., Sukhatme, B. V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Fundamentals of Applied Statistics, S. C. Gupta & V.K. Kapoor.

CC6 : SURVEY SAMPLING & INDIAN OFFICIAL STATISTICS (Practical) (Practical: 2credits)
<p>Practical</p> <ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-6Th.) ▪ Based on Unit 2 (CC-6Th.) ▪ Based on Unit 3 (CC-6Th.) ▪ Based on Unit 4 (CC-6Th.) <p style="text-align: center;">USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

CC7 : MATHEMATICAL ANALYSIS

Course Outcomes

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

- CO1:** Understand over all concepts of algebraic structures.
- CO2:** Apply Mathematical Analysis plays an important role in solving problem in pure mathematics.
- CO3:** Real analysis is important part of pure mathematics. Stress is laid on development of analytical abilities of the students.
- CO4:** Numerical Analysis is a topic of the day and here students is taught some programming methods and solve linear and non-linear equation and analyse & evaluate the accuracy

CC7 : MATHEMATICAL ANALYSIS (Th) (Theory: 6credits)		
Unit	Topics to be covered	No. of Lectures
1.	Ordered Sets and Fields, Metric Spaces, Relative Topology , Compact Sets, Connected Sets, Sequential Compactness, Completeness, Construction of real Numbers.	12
2	Real Analysis- Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets , neighborhoods and limit points, supremum and infimum, derived sets open and closed sets, sequences and their convergence, limits of some special sequences such as r^n , $(1+1/n)^n$ and $n^{-1/n}$ and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.	10
3	Infinite series, positive term series and their convergence, comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test(Statements and Examples only). Absolute convergence series, Leibnitz's test for the convergence of alternating series, conditional convergence. Indeterminate form , L's Hospital's rule.	10
4	Differential Calculus: Limits of Function, continuous functions, properties of continuous functions, partial differentiations and total differentiation. Indeterminate forms L-Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables, constrained optimization technique(with Lagrange multiplier) along with some problems. Jacobian, concavity and convexity, points of inflexion of function, singular points.	12
5	Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's theorems series expansions of $\sin x$, $\cos x$, e^x , $(1+x)^n$, $\log(1+x)$.	16
	TOTAL	60

Suggested Reading :

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram D. and Chaudhary B. A first Course in Mathematical Analysis, Narosa Publishing House, N. Delhi, 1987
3. Gupta S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publishing House Pvt. Ltd., New Delhi, 1995.
4. Apostol T.M. : Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1987.
5. Shanti Narayan: A Course of Mathematical Analysis, 12th revised Edition, S. Chand & co.(Pvt.) Ltd., New Delhi, 1987
6. Singal M.K. and Singal A.R.: A First Course in real Analysis, 24th Edition, S. Chand & co.(Pvt.) Ltd., New Delhi, 2003.
7. Bartle, R.G. and Sherbert, D.R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and sons (Asia) Pvt. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Text in Mathematics, Springer (SIE), Indian reprint.
9. Jain, M.K., Iyengar, S.R.K. and Jain R.K. (2003): Numerical methods for scientific and engineering computation, New Age International Publisher, India

SEMESTER – IV
CC8 : ADVANCED STATISTICAL INFERENCE

Course Outcomes

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

- CO1:** Use various methods of estimation such as method of moments and method of maximum likelihood etc. to find an estimate for unknown population parameter
- CO2:** Understand the concepts of testing of hypothesis, critical region and related theorems with applications as well as decision problems.
- CO3:** Perform various tests of significance for mean, proportion etc.
- CO4:** Develop knowledge of sequential analysis and sequential probability ratio test.

CC8 : ADVANCED STATISTICAL INFERENCE (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Estimation: Problem of estimation, Properties of a good estimator - unbiasedness, consistency, efficiency and sufficiency. Factorization theorem. Cramer-Rao inequality and MVB estimators(statement and applications), Minimum variance unbiased estimator (MVUE), Rao-Blackwell theorem, Completestatistic, Lehmann-Scheffe theorems and their applications.	11
2	Methods of Estimation: Method of moments, method of maximum likelihood , method of minimum Chi-square, basic idea of Bayes estimators. Properties of maximum likelihood estimators (without proof)	11
3	Testing of hypothesis: Null and alternative hypotheses, simple and composite hypotheses, Type-I and Type-II errors, critical region, level of significance, size and power of a test, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).	12
4	Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α , β , A and B, determination of A and B in practice. Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on normal, Poisson, binomial and exponential distributions.	14
TOTAL		48

Suggested Reading :

1. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta. 2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
2. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
3. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley & Sons.
4. Mood A.M, Graybill F.A. and Boes D.C,: Introduction to the Theory of Statistics, McGraw Hill.
5. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
6. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. Iowa State University Press.
7. Fundamentals of Mathematical Statistics , S. C. Gupta & V.K. Kapoor

CC8 : ADVANCED STATISTICAL INFERENCE (Practical) (Practical: 2 credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-8Th.) ▪ Based on Unit 2 (CC-8Th.) ▪ Based on Unit 3 (CC-8Th.) ▪ Based on Unit 4 (CC-8Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

CC9 : LINEAR MODELS

Course Outcomes

After the completion of the course, the student will have to:

- CO1:** Predict the unknown value of dependent variable for known value of independent variable.
- CO2:** Use the techniques of analysis of for testing the dependence of a quantitative variable on a qualitative variable.
- CO3:** Use analysis of covariance (one way) technique for testing the dependence of a quantitative variable on a qualitative variable when we have given a quantitative auxiliary (independent) variable.
- CO4:** Overcome the problems such as multicollinearity and heteroscedasticity which arises due to the violation of assumptions of a linear model.

CC9 : LINEAR MODELS (Theory: 6credits)		
Unit	Topics to be covered	No. of Lectures
1	Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.	12
2	Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.	12
3	Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.	12
4	Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile-quantile plots.	12
5	Applied Linear Model : One variable using methodologies in one way ANOVA, Non Parametric Statistics and Regression, Concepts of Estimation, Hypothesis Testing , Normal Value & p-value, Simple Linear Regression using more than one predictor variable to predict other.	12
TOTAL		60

Suggested Reading :

1. Weisberg, S. (2005). Applied Linear Regression (Third edition). Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons.
4. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

CC10 : STATISTICAL QUALITY CONTROL

Course Outcomes

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

- CO1:** Know the dimension of quality, history of quality, ISO quality standards, quality registration, causes of variation, seven tools of statistical process control and basis of 3σ control charts.
- CO2:** Aware about control charts for variables and attributes, comparison between control charts for variables and attributes. Analysis of patterns on control chart and estimation of process capability.
- CO3:** Understand the acceptance sampling plan, single and double sampling plans and their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.
- CO4:** Understand the concept of six-sigma, lean manufacturing and total quality management (TQM).

CC10 : STATISTICAL QUALITY CONTROL (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Quality: Definition, dimensions of quality, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3- σ Control charts. Control charts for variables: X-bar & R-chart, X-bar & s-chart. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.	12
2	Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.	12
3	Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans. Voice of customers (VOC): Importance and VOC data collection. Critical to Quality (CTQ). Introduction to DMAIC using one case study: Define Phase, Measure Phase, Analyse Phase, Improve Phase and Control Phase.	14
4	The problem of measurement of Psychological & Educational traits, Scaling- Z-score, standard score, Normalised score, T- score, validity of test scores. Reliability of test scores, Index of reliability, Methods of comparison between reliability & validity.	10
	TOTAL	48

Suggested Reading :

1. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
3. Mukhopadhyay, P (2011): Applied Statistics, 2nd edition revised reprint, Books and Allied(P) Ltd.
4. Montgomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt. Ltd.
5. Ehrlich, B. Harris (2002): Transactional Six Sigma and Lean Servicing, 2nd Edition, St. Lucie Press.
6. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.
7. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

CC10 : STATISTICAL QUALITY CONTROL (Practical) (Practical: 2 credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-10Th.) ▪ Based on Unit 2 (CC-10Th.) ▪ Based on Unit 3 (CC-10Th.) ▪ Based on Unit 4 (CC-10Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

SEMESTER – V
CC-11 : Statistical Computing Using C/C++ programming

Course Outcomes

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

- CO1:** Develop various basic concepts, features and components related to C programming language.
CO2: Define data types and use them in simple data processing applications
CO3: Design and develop C programs, analyses and interpret the concept of control statements, array,
CO4: Pointer, function, structure, declaration, initialisation, operators and their uses.

CC-11 : Statistical Computing Using C/C++ programming (Th.) (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	History and importance of C/C++, components, basic Structure programming, Character set, C/C++ tokens, Keywords and identifiers and execution of a C/C++ program . Data types: Basic Data types(Enumerated and derived) , integer variables, character variables, type float, type conversion, arithmetic operators, relational operators, logical Operators.	10
2	Loops and decision control statements- loop- for, while, do...while, decision-if, if- else, switch, conditional operator, other control statements- break, continue. Arrays- Array fundamental-defining array, array elements, Accessing array elements, Initializing arrays, multidimensional arrays, passing arrays to functions, array of objects, strings-string variables, string constants, array of strings members.	10
3	User- Defined functions : A multi- Function program using user defined functions, definition of functions, return values and their types, function prototypes and calls. Category of functions : no arguments and no return values, arguments but no return values, arguments with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of variables.	14
4	Pointers : Declaration and initialization of Pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increment/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers. Structure : Definition and declaring, initialization, accessing structure members, copying and comparison of Structure variables, array of structures, structure pointers. Dynamic memory allocation functions : malloc, calloc and free.	14
TOTAL		48

Suggested Reading :

1. Robert Lafore, ?Object-Oriented Programming in C++?, Galgotia Publications.

- B. Chandra, 'Object-Oriented Programming using C++', Narosa Publications.

CC11 : Statistical Computing Using C/C++ programming (Practical) (Practical: credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-11Th.) ▪ Based on Unit 2 (CC-11Th.) ▪ Based on Unit 3 (CC-11Th.) ▪ Based on Unit 4 (CC-11Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

CC-12 : TIME SERIES ANALYSIS

Course Outcomes

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

- CO1:** Introduction to times series data, application of time series to various fields, Components of a times series, Decomposition of a time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curves, and growth curves.
- CO2:** Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.
- CO3:** Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.
- CO4:** Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Brown's discounted regression, Box-Jenkins method and Bayesian forecasting. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average

CC12 : TIME SERIES ANALYSIS (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction to times series data, application of time series to various fields, Components of a times series, Decomposition of a time series.	10
2	Trend: Estimation of trend by free hand curve method, method of semi averages fitting various mathematical curves, and growth curves. Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.	14
3	Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.	14
4	Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Brown's discounted regression, Box-Jenkins method and Bayesian forecasting. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.	10
TOTAL		48

Suggested Reading :

- Kendall M.G. (1976): Time Series, Charles Griffin.
- Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
- Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied .
- Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

CC12 : TIME SERIES ANALYSIS (Practical) (Practical: credits)
Practical <ul style="list-style-type: none"> ▪ Based on Unit 1 (CC-12Th.) ▪ Based on Unit 2 (CC-12Th.) ▪ Based on Unit 3 (CC-12Th.) ▪ Based on Unit 4 (CC-12Th.) <p style="text-align: center;">USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

SEMESTER – VI
CC13 : Design of Experiments

Course Outcomes

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

- CO1:** Apply the concepts of basic designs like CRD, RBD & LSD in agricultural and industrial design of experiments.
- CO2:** Draw the inferences about the dependency of a variable on an attribute.
- CO3:** Draw the inferences about the dependency of a variable on an attribute.
- CO4:** Implement factorial experiment to analyse the effects of varying levels of two or more factors simultaneously.

CC13 : Design of Experiments (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Experimental designs: Role, historical perspective, terminology, experimental error, basic principles- Randomisation, replication, local control and uniformity trials.	10
2	Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.	14
3	Factorial experiments: advantages, notations and concepts, 2^2 , $2^3 \dots 2^n$ factorial experiments, design and analysis, Total and Partial confounding for 2^n ($n \leq 5$). Factorial experiments in a single replicate.	12
4	Incomplete Block Designs: Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters, incidence matrix and its properties, Symmetric BIBD, Resolvable BIBD, Affine Resolvable BIBD, Intra Block analysis, complimentary BIBD, Residual BIBD, Dual BIBD, Derived BIBD.	12
TOTAL		48

Suggested Reading:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
4. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
5. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
6. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

CC-13 : Design of Experiments (Practical) (Practical: 2 credits)

Practical

- Based on Unit 1 (CC-13Th.)
- Based on Unit 2 (CC-13Th.)
- Based on Unit 3 (CC-13Th.)
- Based on Unit 4 (CC-13Th.)

USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.

CC14 : MULTIVARIATE ANALYSIS & NON- PARAMETRIC METHODS

Course Outcomes

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

- CO1:** Understand bivariate normal distribution, bivariate and multivariate data, random vector, p.m.f, p.d.f., distribution function, mean vector and dispersion matrix, marginal and conditional distributions.
- CO2:** Know the concept of multivariate normal distribution and its properties, sampling distribution of mean vector, concept of multiple and partial correlation coefficient and their properties.
- CO3:** Know the applications of multivariate analysis in discriminant analysis, principal components analysis and factor analysis.
- CO4:** Know about non-parametric test which includes the test of randomness, empirical distribution function, Kolmogorov Smirnov test, sign test and Wilcoxon-Mann-Whitney test, median test and Wilcoxon-Mann-Whitney test.

CC14 : MULTIVARIATE ANALYSIS & NON- PARAMETRIC METHODS (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions	10
2	Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.	14
3	Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis.	10
4	Nonparametric Tests: Introduction and Concept, Wald- Wolfzmann Run test, Test for randomness based on total number of runs, , Sign tests- one sample and two samples, Median test, Mann-Whitney U- test.	14
TOTAL		48

Suggested Reading :

1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972) :Multivariate Analysis, 1stEdn. Marcel Dekker.
4. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall
5. Mukhopadhyay, P. :Mathematical Statistics.
6. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.

CC14 : MULTIVARIATE ANALYSIS & NON- PARAMETRIC METHODS (Practical) (Practical: 2 credits)

Practical

- Based on Unit 1 (CC-14Th.)
- Based on Unit 2 (CC-14Th.)
- Based on Unit 3 (CC-14Th.)
- Based on Unit 4 (CC-14Th.)

Generic Elective
SEMESTER – I

GE1 : STATISTICAL METHODS

Course Outcomes

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

- CO1:** Understand the concept of descriptive Statistics.
- CO2:** Understand the statistical data, types of data, tabular and graphical presentation of data, scales of measurement, measures of central tendency, measures of dispersion, moments, Skewness and Kurtosis, Coefficient of variation.
- CO3:** Understand the Correlation (Simple, Multiple and Partial), Rank Correlation, Intra-class correlation and regression analysis, principle of least squares and fitting of different polynomials and exponential curves.
- CO4:** Understand the consistency of data and independence of attributes, measures of association of attributes

GE1 : STATISTICAL METHODS (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Presentation: tabular and graphic, including histogram and ogives.	12
2	Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.	10
3	Bivariate data: Definition, scatter diagram, Karl Pearson product moment correlation coefficient and its properties, rank correlation, partial and multiple correlation (3 variables only). Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.	14
4	Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.	12
	TOTAL	48

Suggested Reading :

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
4. Fundamentals of Mathematical Statistics, S. C. Gupta & V.K. Kapoor

GE1 : STATISTICAL METHODS (Practical) (Practical: 2 credits)

Practical

- Based on Unit 1 (GE-1Th.)
- Based on Unit 2 (GE-1Th.)
- Based on Unit 3 (GE-1Th.)
- Based on Unit 4 (GE-1Th.)

USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.

SEMESTER – II **GE2 : INTRODUCTORY PROBABILITY**

Course Outcomes

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

- CO1:** Understand the concept of probability and the law related to it.
- CO2:** Comprehend random experiments, sample space, events, various concepts associated with theory of probability, random variables, p.m.f and p.d.f. for univariate random variables, distribution function.
- CO3:** Understand the concepts of mathematical expectations, variance, moments and m.g.f..
- CO4:** Apply standard probability distributions for discrete and continuous random variables.

GE2 : INTRODUCTORY PROBABILITY (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes’ theorem and its applications.	12
2	Random Variables: Discrete and continuous random variables, p.m.f., p.d.f. ,c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.	12
3	Convergence in probability, almost sure convergence, Chebyshev’s inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T.).	12
4	Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.	12
	TOTAL	48

Suggested Reading :

1. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund’s Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
4. Fundamentals of Mathematical Statistics , S. C. Gupta & V.K. Kapoor.

GE2 : INTRODUCTORY PROBABILITY (Practical) (Practical: credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (GE-2Th.) ▪ Based on Unit 2 (GE-2Th.) ▪ Based on Unit 3 (GE-2Th.) ▪ Based on Unit 4 (GE-2Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

SEMESTER – III
GE3 : STATISTICAL INFERENCE

Course Outcomes

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

- CO1:** Theory of estimation.
CO2: Tests of hypothesis.
CO3: Application of Chi-square test.
CO4: Nonparametric tests.
CO5: Analysis of variance.
CO6: Fundamentals and analysis of basic designs (CRD, RCBD).
CO7: Bioassay

GE3 : STATISTICAL INFERENCE (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). The basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).	10
2	Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi- square test, Yates' correction.	14
3	Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.	12
4	Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design.	12
TOTAL		48

Suggested Reading :

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley (2005). Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II (2005).
2. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
3. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences .(1964, 1977) by John Wiley.
4. Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
5. Goldstein, A Biostatistics-An introductory text (1971). The Macmillon New York.
6. Fundamentals of Mathematical Statistics , S. C. Gupta & V.K. Kapoor
7. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor.

GE3 : STATISTICAL INFERENCE (Practical) (Practical: 2 credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (GE-3Th.) ▪ Based on Unit 2 (GE-3Th.) ▪ Based on Unit 3 (GE-3Th.) ▪ Based on Unit 4 (GE-3Th.) 	

SEMESTER – IV
GE4 : APPLIED STATISTICS

Course Outcomes

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

- CO1:** Know components of time series, decomposition of time series, measurement of trend by different methods, measurement of seasonal variations by ratio to trend method.
- CO2:** Understand about Index numbers, criteria for a good index number, different types of index numbers, construction of index numbers, consumer price index number, uses and limitations of index numbers.
- CO3:** Perceive the concept of statistical quality control, importance of statistical methods in industrial research and practice, determination of tolerance limits, causes of variations in quality, general theory of control charts, process and product control, Control charts for variables and attributes.
- CO4:** Grasp the demographic methods, measurement of rates and ratios of vital events, measurement of CDR, SDR, IMR, SDR, life tables, measurement of CBR, GFR and TFR, measurement of GRR and NRR.

GE4 : APPLIED STATISTICS (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Economic Time Series: Components of time series, Decomposition of time series- Additive and multiplicative model with their merits and demerits, Illustrations of time series. Measurement of trend by method of free-hand curve, method of semi-averages and method of least squares (linear, quadratic and modified exponential). Measurement of seasonal variations by method of ratio to trend.	10
2	Index numbers: Definition, Criteria for a good index number, different types of index numbers. Construction of index numbers of prices and quantities, consumer price index number. Uses and limitations of index numbers.	14
3	Statistical Quality Control: Importance of statistical methods in industrial research and practice. Determination of tolerance limits. Causes of variations in quality: chance and assignable. General theory of control charts, process & product control, Control charts for variables: X- bar and R-charts. Control charts for attributes: p and c-charts	12
4	Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates. Life (mortality) tables: definition of its main functions and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR.	12
	TOTAL	48

Suggested Reading :

1. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition World Press, Kolkata.

3. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Applied Statistics, 4th Edition(Reprint), Sultan Chand & Sons
4. Montgomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.
5. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

GE4 : APPLIED STATISTICS (Practical) (Practical: credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (GE-4Th.) ▪ Based on Unit 2 (GE-4Th.) ▪ Based on Unit 3 (GE-4Th.) ▪ Based on Unit 4 (GE-4Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

Discipline Specific Elective (DSE)
SEMESTER – V

DSE1 : OPERATIONS RESEARCH

Course Outcomes

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

- CO1:** The fundamental concepts of Operational Research Techniques
CO2: Linear Programming.
CO3: Transportation and assignment problems
CO4: Game Theory
CO5: Inventory Models

DSE1 : OPERATIONS RESEARCH (Theory:4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Convex sets and their properties, Introduction to linear programming problem, solution by graphical method.	8
2	simplex method, optimality and unboundedness, artificial variables, two-phase method, Big-M method. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.	12
3	Transportation problem and its mathematical formulation, north-west-corner method, least cost method and Vogel approximation method for determination of initial basic solution, algorithm for solving transportation problem. Transportation problem as a linear programming problem	14
4	Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Assignment problem as a linear programming problem	14
TOTAL		48

Suggested Reading :

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
5. Operations Research – S D Sharma.
6. Linear Programming Problems – R K Gupta.

DSE1 : OPERATIONS RESEARCH (Practical) (Practical: 2 credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-1Th.) ▪ Based on Unit 2 (DSE-1Th.) 	

- Based on Unit 3 (DSE-1Th.)
- Based on Unit 4 (DSE-1Th.)

USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.

DSE2 : Stochastic Processes and Queuing Theory

Course Outcomes

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

- CO1:** Predict the future results in terms of probability for the given stochastic models.
CO2: Compute the probability of recurrence of an event.
CO3: Compute the expected duration of game.
CO4: Compute waiting time distributions for various queuing models

DSE2 : Stochastic Processes and Queuing Theory (Theory: credits 6)		
Unit	Topics to be covered	No. of Lectures
1	Stochastic Process: Introduction, Stationary Process	10
2	Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Higher transition probabilities. Classification of states and chains, stability of Markov system	12
3	Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrivaltime, pure birth process, Yule Furry process, birth and deathprocess, pure death process.	14
4	Queuing System: General concept, steady state distribution, queuing model, M/M/1 withfinite and infinite system capacity, waiting time distribution (without proof)	12
TOTAL		48

Suggested Reading :

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat,B.R.(2000): Stochastic Models: Analysis and Applications, New AgeInternational Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice-Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Vol I,3rd Edition, Wiley International.

DSE2 : Stochastic Processes and Queuing Theory (Practical) (Practical: 2credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-2Th.) ▪ Based on Unit 2 (DSE-2Th.) ▪ Based on Unit 3 (DSE-2Th.) ▪ Based on Unit 4 (DSE-2Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

SEMESTER – VI

DSE3 : ECONOMETRICS

Course Outcomes

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

- CO1: The fundamental concepts of econometrics.
- CO2: Specification of the model.
- CO3: Multiple Linear Regression.
- CO4: Multicollinearity.
- CO5: Heteroscedasticity.
- CO6: Autocorrelation.
- CO7: Autoregressive and Lag models.

DSE3 : ECONOMETRICS (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM). Estimation under linear restrictions.	14
2	Multicollinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error.	10
3	Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequences of autocorrelated disturbances, detection and solution of autocorrelation.	12
4	Heteroscedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under heteroscedasticity. Consequences of heteroscedasticity. Tests and solutions of heteroscedasticity. Autoregressive and Lag models, Dummy variables, Qualitative data.	12
	TOTAL	48

Suggested Reading :

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Johnston, J. (1972): Econometric Methods, 2nd Edition, McGraw Hill International.
3. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited.
4. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley & Sons.

DSE3 : ECONOMETRICS (Practical) (Practical: 2 credits)	
Practical	<ul style="list-style-type: none">▪ Based on Unit 1 (DSE-3Th.)▪ Based on Unit 2 (DSE-3Th.)▪ Based on Unit 3 (DSE-3Th.)▪ Based on Unit 4 (DSE-3Th.)
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

DSE4 : DEMOGRAPHY & VITAL STATISTICS

Course Outcomes

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

- CO1: Distinction between Vital Statistics and Demography.
- CO2: Errors in Demographic data.
- CO3: To check the completeness of registration data using Chandrasekaran-Deming formula.
- CO4: Use of Myer's and UN indices in evaluating age data.

- CO5:** Use of Balancing Equations.
CO6: Population Composition and Dependency Ratio.
CO7: Sources of data collection on Vital Statistics and errors therein.
CO8: Measurement of Population.
CO9: Distinction between Rate and Ratio.
CO10: Basic measures of Mortality.
CO11: Concepts of Stable and Stationary Populations.
CO12: Concept of Life Tables, their construction and uses.
CO13: Concept of Abridged life tables and their construction by Reed and Merrell method, Greville's method and King's Method.
CO14: Basic measures of Fertility.
CO15: Measures of Population Growth.

DS4 : DEMOGRAPHY & VITAL STATISTICS (Theory : 4 credit)		
Unit	Topics to be covered	No. of hours
1	Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.	10
2	Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.	12
3	Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.	12
4	Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Greville's method and King's Method. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).	14
	TOTAL	48

Suggested Reading :

1. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P) Ltd.
2. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.
3. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
4. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
5. Keyfitz N., Beckman John A.: Demogrphy through Problems S-Verlag New york.
6. Fundamentals of Applied Statistics , S. C. Gupta & V.K. Kapoor

DSE4 : DEMOGRAPHY & VITAL STATISTICS (Practical) (Practical: 2 credits)	
Practical	<ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-4Th.) ▪ Based on Unit 2 (DSE-4Th.) ▪ Based on Unit 3 (DSE-4Th.) ▪ Based on Unit 4 (DSE-4Th.)
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

DSE5 : Financial Statistics

Course Outcomes

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

- CO1:** Advanced Knowledge and Understanding of Statistical Methods related to common types of Financial and Business Data
- CO2:** Ability to apply Statistical Methods to real Financial Data Sets using Statistical Software.
- CO3:** Ability to interpret the results of the analysis in the context of common finance and business problems
- CO4:** Ability to think critically and make effective decisions based on appropriate Statistical Analysis

DSE5 : Financial Statistics (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Probability review: Real valued random variables, expectation and variance, skewness and kurtosis, conditional probabilities and expectations. Discrete Stochastic Processes, Binomial processes, General random walks, Geometric random walks, Binomial models with state dependent increments.	12
2	Tools Needed For Option Pricing: Wiener processes, stochastic integration, and stochastic differential equations. Introduction to derivatives: Forward contracts, spot price, forward price, future price. Call and put options, zero-coupon bonds and discount bonds	12
3	Pricing Derivatives: Arbitrage relations and perfect financial markets, pricing futures, put-call parity for European options, relationship between strike price and option price. Stochastic Models in Finance: Discrete time process- binomial model with period one.	10
4	Stochastic Models in Finance: Continuous time process- geometric Brownian motion. Ito's lemma, Black-Scholes differential equation, Black-Scholes formula for European options, Hedging portfolios: Delta, Gamma and Theta hedging. Binomial Model for European options: Cox-Ross-Rubinstein approach to option pricing. Discrete dividends	14
	TOTAL	48

Suggested Reading :

1. Franke, J., Hardle, W.K. And Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rd Edition, Springer Publications.
2. Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC.

DSE5 : Financial Statistics (Practical) (Practical: 2 credits)	
Practical	<ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-5Th.) ▪ Based on Unit 2 (DSE-5Th.) ▪ Based on Unit 3 (DSE-5Th.) ▪ Based on Unit 4 (DSE-5Th.)

DSE6 : Survival Analysis and Biostatistics

Course Outcomes

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

- CO1:** To develop background of major theory and Parametric Methods.
- CO2:** To develop background of Survival Analysis and applications in practical settings.
- CO3:** To comprehend Parametric regression analysis.
- CO4:** To comprehend Failure Time Model.
- CO5:** Comprehend the use of models in Bio-Statistics for applications in maximum likelihood principles and Modified Minimum chi square Method.

DSE6 : Survival Analysis and Biostatistics (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Survival Analysis: Functions of survival times, survival distributions and their application exponential, gamma, Weibull, Rayleigh, lognormal, death density function for a distribution having bath-tub shaped hazard function. Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples. Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.	14
2	Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model.	12
3	Stochastic Epidemic Models: Simple epidemic models, general epidemic model definition and concept (without derivation). Duration of an epidemic.	10
4	Statistical Genetics: Introduction, concepts-Genotype, Phenotype, Dominance, Recessiveness, Linkage and Recombination, Coupling and Repulsion. Mendelian laws of Heredity, Random mating, Gametic Array .relation between genotypic array and gametic array under random mating. Distribution of genotypes under random mating. Clinical Trials: Planning and design of clinical trials, Phase I, II and III trials. Single Blinding	14
	TOTAL	48

Suggested Reading :

1. Lee, E.T. and Wang, J.W. (2003): Statistical Methods for Survival data Analysis, 3rd Edition, John Wiley and Sons
2. Biswas, S. (2007): Applied Stochastic Processes: A Biostatistical and Population Oriented Approach, Reprinted 2nd Central Edition, New Central Book Agency.
3. Kleinbaum, D.G. (1996): Survival Analysis, Springer.
4. Chiang, C.L. (1968): Introduction to Stochastic Processes in Bio Statistics, John Wiley and Sons.
5. Indrayan, A. (2008): Medical Biostatistics, 2nd Edition Chapman and Hall/CRC. B. Sc. H

**DSE6 : Survival Analysis and Biostatistics (Practical)
(Practical: credits)**

Practical

- Based on Unit 1 (DSE-6Th.)
- Based on Unit 2 (DSE-6Th.)
- Based on Unit 3 (DSE-6Th.)
- Based on Unit 4 (DSE-6Th.)

USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.

DSE7 : Research Methodology

Course Outcomes

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

- CO1:** Identify and discuss the role and importance of research in social sciences.
- CO2:** Identify and discuss the issues and concepts salient to the research process.
- CO3:** Identify and discuss the complex issues inherent in selecting research problem and implementing a research project.
- CO4:** Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

DSE7 : Research Methodology (Th) (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction to research, meaning of research, role of research in important areas, process of research, types of research, Unit of analysis, characteristics of interest. Research problem as a hypothesis testing Sampling Techniques: Introduction to sampling, advantage of sampling over census, simple random sampling, sampling frame, probabilistic aspects of sampling, stratified random sampling, other methods of sampling, sampling design, non probability sampling methods	12
2	Data: Introduction, primary and secondary data, methods of collecting primary data, merits and demerits of different methods of collecting primary data, designing a questionnaire, pretesting a questionnaire, editing of primary data, technique of interview, collection of secondary data, scrutiny of secondary data, Data Processing: Introduction, editing of data, coding of data, classification of data, tables as data presentation devices, graphical presentation of data	10
3	Data Analysis: An overview on techniques in univariate, bivariate and multivariate data Models and Model Building: role of models, types of models, objectives of modeling, model building/ model development, model validation, simulation models	8
4	Formats of Reports: introduction, parts of a report, cover and title page, introductory pages, text, reference section, typing instructions, copy reading, proof reading. Presentation of a report: introduction, communication dimensions, presentation package, audio-visual aids, presenter's poise.	10
	TOTAL	40

Suggested Reading :

1. Kotahri, C.R (2009): Research Methodology: Methods and Techniques, 2nd Revised

2. Ed. Reprint, New Age International Publishers
3. Lilien, Gary L. and Philip Kotler, 1983. Marketing Decision Making; A Model Building Approach, Harper & Row, New York.
4. Shenoy, GVS, et al., (1983). Quantitative Techniques for Managerial Decision Making, Wiley Eastern

DSE7 : Research Methodology (Practical) (Practical: 2 credits)	
Practical	
<ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-7Th.) ▪ Based on Unit 2 (DSE-7Th.) ▪ Based on Unit 3 (DSE-7Th.) ▪ Based on Unit 4 (DSE-7Th.) 	
USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.	

DSE8 : Actuarial Statistics

Course Outcomes

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

- CO1:** To learn and gain the knowledge about the impact of economic and social conditions in the financial sector.
- CO2:** Develop communication, leadership and teamwork skills and understand their importance in the actuarial industry.
- CO3:** Solve a wide variety of mathematical problems related to the actuarial science field
- CO4:** Demonstrate proficiency in the fundamental concepts of financial mathematics including the theory of interests and financial derivatives.

DSE8 : Actuarial Statistics (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.	12
2	Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.	10
3	Survival Distribution and Life Tables: Uncertainty of age at death, survival function, timeuntil-death for a person, curate future lifetime, force of mortality, life tables with examples, deterministic survivorship group, life table characteristics, assumptions for fractional age, some analytical laws of mortality.	14
4	Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships. Life annuities: continuous life annuities, discrete life annuities, life annuities with periodic payments. Premiums: continuous and discrete premiums.	12

	TOTAL	48
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Suggested Reading :

1. Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On
2. Actuarial Science), Cambridge University Press.
3. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A. And Nesbitt, C. J. (1997):
4. Actuarial Mathematics, Society Of Actuaries, Itasca, Illinois, U.S.A.

DSE8 : Actuarial Statistics (Practical) (Practical: 2 credits)
<p>Practical</p> <ul style="list-style-type: none"> ▪ Based on Unit 1 (DSE-8Th.) ▪ Based on Unit 2 (DSE-8Th.) ▪ Based on Unit 3 (DSE-8Th.) ▪ Based on Unit 4 (DSE-8Th.) <p style="text-align: center;">USE OF SCIENTIFIC CALCULATOR WILL BE ALLOWED IN PRACTICAL EXAMS.</p>

DSE9 : Statistical Data Analysis Using R

Course Outcomes

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

- CO1:** The module aims to provide exposure in terms of statistical analysis, Hypothesis testing and statistical inference in order to find p-values.
- CO2:** Start E programming is an all-inclusive training program that aims at building a skill-set to tackle real-world data analysis.
- CO3:** To understand subset data vectors and lists for applications in family of functions for subsetting and basic computations
- CO4:** Study and practice of data analysis and graphical interpretation using R.

DSE9 : Statistical Data Analysis Using R (Th) (Theory: credits)		
Unit	Topics to be covered	No. of Lectures
1	Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data	10
2	Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.	8
3	Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.	10
4	Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.	12
TOTAL		40

Suggested Reading :

1. Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley
2. Publications.
3. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R.
4. Cambridge University Press. New York

