MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI – 12.

B.Sc. Statistics

(Choice Based Credit System)
(with effect from the academic year 2017-2018)

Eligibility for Admission:

Candidates who have passed the higher secondary examination conducted by Government of Tamil Nadu with Statistics / Mathematics / Business Mathematics / Computer Science / Physics / Chemistry / Commerce as one of the subjects or other equivalent examinations are eligible for admission to the first year of the B.Sc., (Statistics) degree course.

Duration of the Course:

The duration of the course is three academic years comprising of six semesters with two semesters in each academic year. Examinations will be conducted at the end of each semester for the respective subjects.

Medium of Instructions and Examinations:

The medium of instructions and examinations for the subjects of Part I and Part II shall be in the languages concerned. For the subjects of Part III and Part IV, the medium of instructions and examinations shall be in English.

Examination

The regulations for examination, passing minimum in each subject and classification of successful candidates and award of ranks are at par with the regulations for other undergraduate science courses of the University.

SCHEME OF EXAMINATION

Sem.	Part I/II/ III/ IV/ V	Course No.	Course Status	Course Title	Credits	Contract Hrs./week
III	I	17	Language	Tamil / Other Languages – III	4	6
	II	18	Language	English – III	4	6
	III	19	Core	Statistical Distributions	4	4
	III	20	Major Practical - III	Statistics Practical - III	2	2
	III	21	Allied-III	Mathematics - II	3	3
	III	22	Allied Practical - III	Statistical Computations using Software - I	2	2
	III	23	Skilled Based Core	Mathematical Computations using R	3	3
	IV	24	Non-Major Elective	Elements of Statistics - I	2	2
		25	Common	Yoga	2	2
	Subtotal				**26**	**30**

	I	26	Language	Tamil / Other Languages – IV	4	6
	II	27	Language	English – IV	4	6
	III	28	Core	Demographic Methods	4	4
	III	29	Major Practical - IV	Statistics Practical - IV	2	2
	III	30	Allied- IV	Matrix Theory	3	3
IV	III	31	Allied Practical - IV	Matrix Computations	2	2
	III	32	Skill Based Core	Numerical Methods	3	3
	IV	33	Non-Major Elective	Elements of Statistics - II	2	2
	IV	34	Common	Computers for Digital Era	2	2
	V	35	Extension Activity	NCC, NSS, YRC, YWF	1	0
				Subtotal	**27**	**30**
	III	36	Core	Statistical Inference – I	4	4
	III	37	Core	Statistical Quality Control	4	4
	III	38	Elective	Major Elective – I (Econometrics / Stochastic Processes)	4	4
	III	39	Elective	Major Elective – II (Actuarial Statistics / Biostatistics)	4	4
	III	40	Major Practical – V	Statistics Practical - V	2	4
V	III	41	Major Practical - VI	Statistics Practical - VI	2	4
	III	42	Major Practical - VII	Statistics Practical - VII	2	4
	IV	43	Skill Based- Common	Personality Development / Effective Communication / Youth Leadership	2	2
				Subtotal	**24**	**30**
	III	44	Core	Statistical Inference – II	4	5
	III	45	Core	Design of Experiments	4	5
	III	46	Core	Operations Research	4	4
	III	47	Elective	Elective - III (Discrete Mathematics / RDBMS with ORACLE)	4	4
VI	III	48	Major Practical - VIII	Statistics Practical - VIII	2	4
	III	49	Major Practical - IX	Statistics Practical - IX	2	4
	III	50	Major Practical - X	Statistics Practical - X	2	4
				Subtotal	**22**	**30**

Note 1:

Statistics Practical – I   : Based on the subject "Descriptive Statistics" and "Probability Theory"

Statistics Practical – II   : Based on the subject "Sampling Techniques" and "Time Series and Official Statistics"

Computer Practical – I   : Based on the subject "Programming with C"

Statistics Practical – III   : Based on the subject "Statistical Distributions"

Statistics Practical – IV   : Based on the subject "Demographic Methods"

Matrix Computations   : Based on the subject "Matrix Theory"

Statistics Practical – V   : Based on the subject "Statistical Inference – I"

Statistics Practical – VI   : Based on the subject "Statistical Quality Control"

Statistics Practical – VII   : Based on the subject Elective – II (Actuarial Statistics / Bio Statistics)

Statistics Practical – VIII : Based on the subject "Statistical Inference – II"

Statistics Practical – IX   : Based on the subject "Design of Experiments"

Statistics Practical – X   : Based on the subject "Operations Research"

Note 2:

Elective – I: Econometrics
               Stochastic Processes
Elective – II: Actuarial Statistics
               Biostatistics
Elective - III: Discrete Mathematics
               RDBMS with ORACLE)

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SEMESTER – III

3.3 STATISTICAL DISTRIBUTIONS (Core)

L T P C
4 0 0 4

Preamble : To enable the students to understand the properties and applications of various probability functions.

Unit - I

Distribution functions of two dimensional random variables – applications of Jacobian, marginal and conditional distributions - expectation. **(12L)**

Unit - II

Discrete distributions: Bernoulli, Binomial, Poisson, Geometric and Negative binomial distributions – Hyper geometric distribution, Multinomial distribution and discrete Uniform distribution- Moments – moment generating function, Characteristic function and their properties. **(12L)**

Unit - III

Continuous distributions: Uniform, Normal, Cauchy and Lognormal distributions - concepts, moments, moment generating and characteristic functions and their properties.
(12L)

Unit - IV

Exponential, Gamma, Beta (first and second kinds) concepts, moments, moment generating and characteristic functions and their properties. **(12L)**

Unit - V

Sampling distributions: Chi-square, t and F distributions- concepts, moments, moment generating and characteristic functions and their properties. **(12L)**

(Total: 60L)

BOOKS FOR STUDY:
1. Rohatgi, V. K. and A. K. md. Ehsanes Saleh (2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
2. Alexander, M. Mood, Franklin A. Graybill and Duane C. Boes (1974) Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Comp Ltd. New Delhi.
3. Gupta, S. C., and V. K. Kapoor (2000) Fundamentals of Mathematical Statistics, A Modern Approach (Eighth Edition). Sultan Chand & sons. New Delhi.
4. Bhuyan K.C. (2010), Probability Distribution Theory and Statistical Inference, New Central Book Agency.
5. Parimal Mukopadhyay (2006) Mathematical Statistics, (Third Edition), Books and Allied Private Limited, Kolkata.
6. Robert, V. Hogg and Allen T. Craig (2012) Introduction to Mathematical Statistics (Fourth Edition), Macmillan Publishing Co., Inc. New York.
7. Edward J. Dudewicz and Satya N. Mishra (2007). Modern Mathematical Statistics, John Wiley & Sons. Inc., New York.

3.5 MATHEMATICS – II (Allied)

L T P C
3 0 0 3

Preamble : To explore the concepts of Mathematics.

Unit - I

Theory of Equations: Nature of roots, Formulation of equation whose roots sre given. Relation between coefficients and roots - Transformation of equations - Reciprocal equations - Horner's method of solving equations. **(10L)**

Unit - II

Successive differentiation – Trignometrical tranformations - Leibnitz's Formulas, nth derivatives of standard functions - simple problems. Partial differentiation – Successive partial differentiation – Implicit functions – homogeneous functions – Euler's theorem. **(10L)**

Unit - III

Maxima and Minima for one variable – Applicationas – Concavity, Convexsity and points of inflexion - Maxima and Minima for two variables – working rule. **(10L)**

Unit – IV

Linear differential equations of second order with constant coefficients - $(aD^2+bD+c)y = X$, various forms of X : $e^{\alpha x}$, $\cos \alpha x \sin \alpha x$, x^m. Methods of solving homogenious linear differential equations of second order. Laplace transform and its inverse – solving ordinary differential equation with constant coeficients using Laplce transform.

(10L)

Unit - V

Integration- Reverse process of differentiation – Methods of integration - Integrals of functions containing linear functions of x - Integrals of functions involving $a^2 \pm x^2$ - Integration of rational algebraic functions - $1/(ax^2+bx+c)$, $(px+q)/(ax^2+bx+c)$. Integration of irrational functions - $1/(ax^2+bx+c)^{1/2}$, $(px+q)/(ax^2+bx+c)^{1/2}$, $(px+q)\sqrt{(ax^2 + bx + c)}$ - Integration by parts. **(10L)**

(Total: 50L)

BOOKS FOR STUDY:
1. Narayanan, S. and T.K. Manicavachagom Pillay (2008) Calculus Vol. II and III, S. Viswanathan Pvt. Ltd, Chennai.
2. Narayanan,S., Hanumantha Rao and T.K. Manicavachagom Pillay (2008) Ancillary Mathematics, Volume I, S. Viswanathan Pvt. Ltd, Chennai.

3.6 STATISTICAL COMPUTATIONS USING SOFTWARE - I

L T P C
0 0 2 2

Preamble : To compute the various measures using computers.

Unit –I
- Solving a system of equations applying Cramer's rule and Inverse of matrix.
- Fitting of linear and quadratic models.

Unit –II
- Construction of frequency table - univariate, bivariate data.
- Drawing frequency graphs.
- Construction of diagrams: Bar diagrams, Pie diagrams etc.

Unit – III
- Calculation of measures of central tendency - mean, median and mode.
- Calculation of measures of dispersion - quartile deviation, standard deviation, coefficient of variation.

Unit – IV
- Calculation of Karl Pearson's coefficient of correlation.
- Fitting of simple linear regression equation.

Unit - V
- Fitting of binomial distribution.
- Fitting of Poisson distribution.
- Fitting of normal distribution.

3.7. MATHEMATICAL COMPUTATIONS USING R

L T P C
2 0 1 3

Preamble : To enable the students to understand the basic concepts of R and how to apply the R in descriptive and probability functions.

UNIT–I
Introduction - History of R programming - R commands – Random numbers generation – Data Types – Objects – Basic data and Computations – Data input – Data frames – Graphics – Tables. **(8L)**

UNIT–II
Descriptive Statistics - Diagrammatic representation of data - measures of central Tendency - measures of dispersion - measures of skewness and kurtosis. **(8L)**

UNIT–III
Probability and probability distributions - problems on finding basic probabilities - some special discrete distributions – Bernoulli distribution - Binomial distribution – Poisson Distribution – Geometric Distribution. **(8L)**

UNIT–IV
Continuous distributions – Normal distribution – Uniform distribution – Gamma distribution – Exponential distribution - sketching graphs for various distributions. **(8L)**

UNIT–V
Correlation - inference procedure for correlation coefficient - bivariate correlation - multiple correlations - Linear regression and its inference procedure. **(8L)**

(Total: 40L)

BOOKS FOR STUDY:
1. Normal Maltoff (2009) The art of R programming, William Pollock Publishers, San Fransisco
2. Purohit S. G., Gore S. D. and Deshmukh S. K. (2010) Statistics using R, Narosa Narosa Publishing House Pvt. Ltd., New Delhi.
3. John Braun, W. and Duncan James Murdoch (2007) First Course in Statistical Programming with R, Cambridge University Press, Uk.
4. Ugarte, M. D., A. F. Militino, A. T. Arnholt (2008) Probability and Statistics with R, CRC Press, Taylo & Francis Group, London.
5. Peter Dalgaard (2008) Introductory Statistics with R, Springer India Private Limited, New Delhi.
6. Michael J. Crawley (2007) The R Book, John Wiley and Sons, New York.

3.8 ELEMENTS OF STATISTICS – I (Elective Non-Major)

L T P C
2 0 0 2

Preamble : To introduce a few concepts in statistics for other major students.

UNIT I
Nature and scope of statistics - characteristics and limitation of statistics - statistical investigation - preparation of questionnaire - design of sampling - simple random, stratified and systematic sampling - collection of data - primary and secondary data.
(8L)

UNIT II
Processing and presentation of data - Classification of data - tabulation of data - Formation of frequency tables - Diagrammatic presentation of statistical data - bar diagrams - pie diagrams and pictograms - simple problems - Graphical presentation of statistical data - Histogram, frequency curves and Ogive curve - simple problems. (8L)

UNIT III
Measures of Central tendency: Arithmetic Mean, Median, Mode. Measures of Dispersion: Range, Inter-Quartile Range, Standard Deviation and Coefficient of Variation.
(8L)

UNIT IV
Simple Correlation- Regression – Bi-serial correlation coefficient - Kendall's coefficient of correlation - Tetrochoric correlation coefficient - Partial and Multiple correlation coefficients (Three variables). Simple problems with application in biology.
(8L)

UNIT V
Concept of Skewness and Kurtosis - Karl Pearson's and Bowley's coefficients of Skewness- moments- coefficients of Skewness and Kurtosis - simple problems.   (8L)
(Total: 40L)

BOOKS FOR STUDY:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Volume-I, World Press Ltd, Calcutta.
2. Gupta, S.C. and V.K. Kapoor. (2000): Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Hogg, R.V., McKean, J.W. and Craig, A.T. (2013). Introduction to Mathematical Statistics (SeventhEdition). Pearson Education Ltd.
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A. (2012): Probability and Statistics, Schaum's Outline Series (Fourth Edition). McGraw- Hill Publishing Company, New Delhi.

SEMESTER – IV

4.3 DEMOGRAPHIC METHODS (Core)

L T P C
4 0 0 4

Preamble : To make the students to ynderstand the application of statistical methods in population related problems.

Unit - I

Demography Data: Demography – definition-sources of demographic data - population census -demographic surveys - Registration method: vital registration - population register and other administrative records, registration of population in India.   **(12L)**

Unit - II

Fertility: Fertility measurements – crude birth rates - general, specific and total fertility rates -gross and net reproduction rates and their interpretation.   **(12L)**

Unit - III

Mortality: Mortality measurements: crude death rate - specific death rate - standardized death rate - infant mortality rate – maternal mortality rate – case fertility rate - comparative mortality index.   **(12L)**

Unit – IV

Life Table and Migration: Description and construction of various columns of a life table and their relationships - uses of life table – migration-factors effecting migration - gross and net migration rates.   **(12L)**

Unit - V

Population Growth: Population projection – population estimates and projection – arithmetic, geometric and exponential growth rates - logistic curve and its suitability for graduating population data - Basic ideas of stationary and stable population.   **(12L)**

(Total: 60L)

BOOKS FOR STUDY:
1. V.C.Sinha E.Zacharia (2012) Elements of demography, Allied Publishers, New Delhi.
2. Agarwala, S.N. (1991) Indian Population Problems, Tata Mc Graw Hill Publishing House, New Delhi.
3. Gupta, S.C, and V. K. Kapoor (2007) Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi.
4. Mishra, D.E. (1982) An introduction to the Study of Population, South India Publishers, Madras.
5. Hansraj, D.R. (1981) Fundamentals of Demography, Surjeet publications, New Delhi
6. Asha A. Bhende and Tara Karitkar (1994) Principles of Population Studies, Himalaya Publishing House Pvt Ltd., Mumbai.
7. Suddhendu Biswas and G. L. Sriwatav (2006), Stochastic Processes in Demography and Applications, New Central Book Agency, London.

4.5 MATRIX THEORY (Allied)

L T P C
3 0 0 3

Preamble : To make the students get understanding the elementary concept of matrices.

Unit - I

Matrices and System of Linear Equations: Transpose-Conjugate transpose. Adjoint of a matrix, Inverse of a matrix, Singular and Non -Singular matrices. Orthogonal and Unitary matrices. Use of inverse of a matrix to find the solution of a system of linear equations - conditions for consistency of equations. **(10L)**

Unit - II

Rank of a matrix: Elementary transformations, Elementary matrices, Row and Column ranks – rank of a matrix. Invariance of rank through elementary transformations, Reduction to Normal form, Rank of sum and product of matrices, Equivalent matrices. **(10L)**

Unit - III

Characteristic Roots and Vectors: Matrix polynomials, Characteristic roots and vectors, Cayley- Hamilton theorem, Minimal equation of a matrix. **(10L)**

Unit – IV

Matrix Algebra: Introduction – Operations on Matrices – Symmetric and Skew-symmetric Matrices – Conjugate of a Matrix – Determinant of a Matrix – Adjoint and Inverse of a Matrix – Singular and Non-singular Matrices - Inverse of Matrices. **(10L)**

Unit - V

Quadratic Forms: Quadratic Form – Matrix of a quadratic form – rank, signature and classification of quadratic forms – Sylvester's of Inertia. **(10L)**

(Total: 50L)

BOOKS FOR STUDY:
1. Vasishtha,A.R.(2014) Matrices, Krishna Prakashan, Meerut.
2. Shanthi Narayan. and Mittal,P.K. (2000) A Text Book of Matrices, S.Chand& Co, New Delhi
3. Gentle,J.E. (2007) Matrix Algebra Theory, Computations, and Applications in Statistics, Springer, New York.
4. Richard Bronson. (2011) Matrix Operations, Schaum'sOuline Series, McGraw Hill, New York.
5. Searle, S. R. (2006) Matrix Algebra useful for Statistics, Wiley Interscience, New York.

4.6 MATRIX COMPUTATIONS

L T P C
0 0 2 2

Preamble : To compute the various mathematical measures using computers.

Unit I
Matrices - R, R2, R3 as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R2, R3.

Unit II
Translation, Dilation, Rotation, Reflection in a point, line and plane.

Unit - III

Matrix form of basic geometric transformations. Interretation of eigenvalues and eigenvectors for such transformations and eigenspaces as invariant subspaces.

Unit - IV
Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations.

Unit - V
Rank of matrix. Solutions of a system of linear equations using matrices.

BOOKS FOR STUDY:
1. George B. Thomas, Jr., Ross L. Finney : Calculus and Analytic Geometry, Pearson Education (Singapore); 2001.
2. T.M. Apostal : Calculus, vol. 1, John Wiley and Sons (Asia) : 2002.
3. A.I. Kostrikin: Introduction to Algebra, Springer Verlag, 1984.

4.7 NUMERICAL METHODS (SBS)

L T P C
3 0 0 3

Preamble : To enable the students to establish mathematical functions using numerical data and to estimate functional relationship, interpolate and extrapolate the value of dependent variable.

Unit - I

Elimination method, Gauss -Jocobian and Gauss- Seidel methods. Solving system of linear equations using Cramer's rule and inverse of matrix. **(10L)**

Unit - II

Solving algebraic equations: Bisection method, False position method, Newton - Raphson method. **(10L)**

Unit - III

Operators and differences: Operators – E, Δ, δ and ∇, and their relationship and their role in difference tables.

Interpolation: Solving problems for equidistant cases using Newton's forward and Backward difference formula - Lagrange's formula for unequal intervals. **(10L)**

Unit - IV

Numerical differentiation – Newton's forward and backward formula – maxima and minima using numerical methods. **(10L)**

Unit - V

Numerical Integration: Trapezoidal rule - Simpson's one - third rules and three-eighth rule – Gragry Formula, Newton – Cole's formula. **(10L)**
(Total: 50L)

BOOKS FOR STUDY:

1. Sastry, S. S. (2005) Introductory Methods of Numerical Analysis, Prentice Hall of India.
2. Atkinson, K. (2004) Elementary Numerical Analysis (2nd Edition), John Wiley & sons, New York.
3. Gerald, C. F. and P. O. Wheatley (2003) Applied Numerical Analysis (4th Edition), Addison-Wesley.
4. James B. ScarBorough, (2010) Numerical Mathematical Analysis (6th Edition) Oxford & IBH publishing Co.,
5. Jain, M. K., S. R. K. Iyengar, R.K. Jain (2010) Numerical Methods for Scientific and Engineering Computation (Second Edition), Wiley Eastern Limited, New Delhi.

4.8 ELEMENTS OF STATISTICS – II (Non-Major Elective)

L T P C
2 0 0 2

Preamble : To introduce a few concepts in statistics for other major students.

UNIT I
Definition of Statistics and its applications in various disciplines - Collection of Data - classification, Tabulation and Graphical representation of data - construction of univariate and Bivariate frequency distribution. **(8L)**

UNIT II
Random experiment - sample space - events - mathematical and statistical definition of probability - conditional probability – Bayes' theorem - Random variables - Distribution functions - moments - Binomial distribution - Poisson distribution - Normal distribution and their properties. **(8L)**

UNIT III

Tests of significance - hypotheses - two types of errors - power function - critical region - level of significance - small sample tests based on t and F distributions. Chi-square test of goodness of fit - contingency table -Test of independence of factors - Large sample tests. **(8L)**

UNIT IV
Small sample and Large sample tests: Test for the significance of population mean when population variance is (i) known and (ii) unknown - Tests of significance for testing the equality of means of two normal populations when population variances (i) known and (ii) unknown. **(8L)**

UNIT V
Analysis of Variance: One way classification - Two way classification - Kruskal-Wallis one way analysis of variance by ranks, Friedman two-way analysis of variance by ranks. **(8L)**

BOOKS FOR STUDY:
1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Volume-I, World Press Ltd, Calcutta.
2. Gupta, S.C. and V.K. Kapoor. (2000): Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Hogg, R.V., McKean, J.W. and Craig, A.T. (2013). Introduction to Mathematical Statistics (SeventhEdition). Pearson Education Ltd.
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A. (2012): Probability and Statistics, Schaum's Outline Series (Fourth Edition). McGraw- Hill Publishing Company, New Delhi.

SEMESTER – V

5.1 STATISTICAL INFERENCE - I (Core)

L T P C
4 0 0 4

Preamble : To enable the students to understand and apply various estimation procedures.

Unit - I

Statistical Inference: meaning and purpose, parameter and statistic. Sampling distribution and standard error. Estimator and estimate. Point Estimation : consistency, unbiasedness, efficiency and sufficient statistic - Neyman's factorization theorem (without proof) - simple problems. **(12L)**

Unit - II

Unbiased Estimation: Minimum variance unbiased estimator - Cramer-Rao Inequality and Rao-Blackwell theorem-applications and simple problems. **(12L)**

Unit - III

Methods of estimation: Methods of moments and maximum liklihood. Properties of estimators obtained by these methods. Method of Least Squares for regression models. asymptotic properties of maximum liklihood estimations (without proof). **(12L)**

Unit - IV

Interval estimation for proportions, mean(s), variance(s) based on Chi-square, Student's t, F and normal distributions – simple problems. **(12L)**

Unit - V

Bayes estimation: concepts of prior, posterier and conjugate prior. Loss function: 0-1 loss function and quadratic error loss function. Bayes estimator. Simple problems involving quadratic error loss function. **(12L)**

(Total: 60L)

BOOKS FOR STUDY:

1. Rohatgi, V. K. and A. K. md. Ehsanes Saleh (2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
2. Gupta, S.C., and V.K. Kapoor (1992) Fundamentals of Mathematical Statistics, A Modern Approach (Eighth Edition). Sultan Chand & sons, New Delhi.
3. Goon, A. M., M.K. Gupta, and B. Dasgupta (2005) Fundamentals of Statistics, Vol. I, (Eigth Edition), World Press, Kolkata.
4. Harold J. Larson (1982) Introduction to Probability Theory and Statistical Inference (Third Edition), John wiley & Sons. Inc., New York.
5. Robert V. Hogg, and Allen T.Craig (1978) Introduction to Mathematical Statistics (Fourth Edition), Macmillan Publishing Co., Inc., New York.
6. Alexander M. Mood, Franklin A. Graybill, and Duane C. Boes(1974) Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Co., Ltd., New York.
7. Rice, J.A. (2007) Mathematical Statistics & Data Analysis (Third Edition), Thomos Brooks/colt, Singapore.
8. Edward J. Dudewicz, and Satya N. Mishra (1988) Modern Mathematical Statistics, John Wiley & Sons. Inc., New York.
9. Parimal Mukopadhyay (2006) Mathematical Statistics (Third Edition), Books and Allied Private Limited, Kolkata.

5.2 STATISTICAL QUALITY CONTROL (Core)

L T P C
4 0 0 4

Preamble : To enable the students to know the concepts of process control and product control.

Unit - I
Control charts for variables: Quality control and need for statistical quality control techniques in industries - causes of variation - process control and product control. Process control: specifications and tolerance limits-3σ limits, construction of Shewhart control charts - variable control charts - $\overline{X}$, R and σ charts- simple problems. **(12L)**

Unit - II
Control charts for attributes: control chart for fraction defectives (p chart), control chart for number of defectives (d chart) and control chart for number of defects per unit (c chart)-simple problems. **(12L)**

Unit - III
Acceptance Sampling: Product control - Sampling inspection, acceptance sampling by attributes-concepts of producer's risk and consumer's risk-acceptable quality level (AQL), lot tolerance percent defective (LTPD), average outgoing quality level (AOQL), ATI and ASN. Rectifying inspection plans. **(12L)**

Unit - IV
Acceptance sampling by attributes: Single sampling plan - OC, AOQ, ATI and ASN curves - Dodge and Romig sampling plans –Double sampling plan and its advantages over single sampling plan, Operating procedure. **(12L)**

Unit - V
Acceptance sampling for variables-sampling plan based on normal distribution-known and unknown standard deviation cases. Determination of n and k for one- sided specification limits - OC curve. **(12L)**
(Total: 60L)

BOOKS FOR STUDY:
1. Montgomery, D.C. (1991) Statistical Quality Control (2nd Edition) John Wiley and Sons, New York.
2. Eugene L. Grant, and Richard S. Leavenworth (1988) Statistical Quality Control (Sixth Edition), McGrawhill Book co, New York.
3. Gupta, S. C. and V.K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & sons, New Delhi.
4. Goon, A. M., M.K. Gupta and B. Dasgupta (1987) Fundamentals of Statistics, Vol. II. World Press, Kolkata.
5. Mahajan (1997) Statistical Quality Control, Dhanpat Rai & sons, New Delhi.
6. Juran, J.M.(1988) Quality Control Handbook, McGraw Hill, New York.

ELECTIVE- I

1. ECONOMETRICS

L T P C
4 0 0 4

Preamble : To enable the students to learn mathematical and statistical tools in Economics.

Unit - I
Model with one explanatory variable: Definition, scope and objectives of Econometrics. Linear model with one independent variable - Least squares estimators of regression coefficients, properties of least squares estimators - analysis of variance to regression model. **(12L)**

Unit - II
Model with more variables: Linear model with more than one explanatory variables – assumptions – estimation of model parameter - Least squares estimators and their properties. Hypothesis testing – test the overall significance of the regression – Testing the individual regression coefficients. **(12L)**

Unit - III
Adequacy of Model: Model adequacy checking – residual analysis – residuals – standardized residuals – residual plot – normal probability plot – plot of residuals against estimated response. A formal test for lack of fit of the model. **(12L)**

Unit - IV
Autocorrelation: Meaning of serial independence – sources of autocorrelation – first order autoregressive scheme – consequences of autocorrelation – Durbin – Watson test – analysing the model in the presence of autocorrelation. **(12L)**

Unit - V
Multicollinearity : meaning and sources – consequences of multicollinearity. Test for detecting multicollinearity – Examining the correlation matrix – Variance Inflation factor – Eigen values of $X'X$. **(12L)**
(Total: 60L)

BOOKS FOR STUDY:
1. Montgomery, D.C, Peck, E.C and Vining, G.G (2003) Introduction to Linear Regression Analysis (Third Edition). Wiley India, New Delhi.
2. Koutsoyiannis, A. (2006) Theory of Econometrics. (Second Edition) Palgrave, New York.
3. Singh, S. P., Parashar, K. and Singh, H. P. (1980) Econometrics. Sultan Chand & Co., New Delhi.
4. Klein, L. R. (1975) A Text Book of Econometrics (Second Edition). Prentice Hall of India, New Delhi

3. STOCHASTIC PROCESSES

L T P C
4 0 0 4

Preamble : To enable the students to know the basic concepts of stochastic processes.

Unit - I

   Elements of Stochastic Processes: Basic terminologies. Classification of stochastic processes according to state space and domain-Elementary ideas on the Poisson process and Wiener process-Martingales-Markov processes- Stationary processes.   **(12L)**

Unit - II

   Markov Chain: definition-transition probability- discrete time Markov chain and transition probability matrix. spatially homogeneous Markov Chain-one -dimensional random walk.   **(12L)**

Unit - III

   Classification of states of Markov Chain. Reducible and irreducible Markov Chains-periodicity. Recurrent and transient states with examples. Concepts, results and problems concerning limiting probabilities (without Proof)- Simple problems.   **(12L)**

Unit - IV

   Classical examples of continuous time Markov Chain- infinitesimal generator - Poisson processes. General pure birth process and Yule's process. Birth and death processes - their differential and difference equations and solutions.   **(12L)**

Unit - V

   Queueing models and Classifications – Queueing system - Definition of transient and Steady-states - Kendall's notations and classification of queuing models - Distributions in queuing systems.   **(12L)**
          (Total: 60L)

BOOK FOR STUDY:
1. Medhi, J. (1994) Stochastic Processes (Second Edition). Wiley Eastern Limited, New Delhi.
2. Samuel Karlin and Taylor (1975) A First Course in Stochatic Processes. Academic Press, NewYork.
3. Bhat, U. N. (1972) Elements of Applied Stochastic Processes. John Wiley & Sons, New York.
4. Basu, A.K. (2005) Introduction to Stochastic Process, Narosa Publishing House Pvt. Ltd., New Delhi.

ELECTIVE – II

1. ACTUARIAL STATISTICS

L T P C
4 0 0 4

Preamble : To impact basic concepts in actuarial studies and to make the students to take up the career in acuarial practice.

Unit - I

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

(12L)

Unit - II

Redemption of loans – Redemption of loans by installments payable times in a year Interest being p.a. effective. Role of probability distribution in general insurance (Weibull, Exponential).   **(12L)**

Unit - III

Vital Statistics – meaning and uses of vital statistics – Measures of mortality – C.D. R, S.D.R., A.S.D.R. – Central mortality rate – Force of mortality – measures of fertility – C.B.R., G.F.R., A.S.F.R., T.F.R, G.R.R. and N.R.R.   **(12L)**

Unit - IV

Mortality Table – Columns of a mortality table – Completing an incomplete mortality table and uses of mortality table – Expectation of life – Computing probabilities of survival and death using mortality tables – select mortality table – Ultimate mortality table – Aggregate morality table.   **(12L)**

Unit - V

Principle of insurance – Assurance benefits – Types of assurance – Endowment assurance, pure endowment assurance, whole life insurance and temporary assurance – Premiums – Natural premium – Level premium – Net premium – Office premium – Bonus loading with profit and without profit – Policy value – Retrospective policy value and prospective policy value.   **(12L)**
(Total: 60L)

BOOKS FOR STUDY:
1. Mathematical basis of Life Assurance (IC-81) Published by Insurance Institute of India, Bombay.
2. Gupta, S.C. and Kapoor, V.K. (1999) Fundamentals of Applied Statistics (3rd Edition), Sultan Chand & Co., New Delhi, (*for Unit III only*).

2. BIO-STATISTICS

L T P C
4 0 0 4

Preamble : To enhance the students apply statistical methods in bio statistics.

UNIT I
Introduction Definition/Phases of Clinical Trials; Study Design: Cohort, case-control and observational studies; Terminology of prospective, retrospective; treatment allocation, randomization and stratification, biases, sample size requirements, patient consent, various types of clinical data (continuous, categorical, count, and time-to-event outcome data). **(12L)**

UNIT II
Basic biological concepts in genetics, Basic concept of Bioassays and different Types of biological assays. Disease-Exposure Association: Risk, odds, odds ratio, relative risk, standard errors; Contingency Tables: Association (Chi-square test), Confounding (Mantel-Haenszel), Interactions (Test of homogeneity); Probability Diagnostic Testing and Screening.
(12L)

UNIT III
Descriptive Statistics; Estimation for Means; Estimation for Proportions; One Sample Hypothesis Test – Means ; One Sample Hypothesis Test – Proportions; Two Sample Hypothesis Test; Non-Parametric Hypothesis Testing; One Way ANOVA; **(12L)**

UNIT IV
Introduction to Linear Regression and Correlation; Logistic Regression: estimation: Logistic regression for case-control studies, estimation and interpretation of logistic parameters.**(12L)**

UNIT V
Introduction to Survival: Concepts of time, Censoring-different types of censoring- right and left, Survival function- Kaplan-Meier (K-M) estimator; Nonparametric Methods for Comparing Survival Distributions - log rank test, Peto's test, Gehan test, Mantel-Haenzel test. **(12L)**
(Total: 60L)

Reference
1. Fundamentals of Biostatistics: Bernard Rosner Recommended 6th /7th Edition
2. Friedman, Furberg & DeMets: Fundamentals of Clinical Trials, 3rd Edition, 1996. Mosby-Year Book, Inc.
3. Rossi R.J. (2010).Applied Biostatistics for Health Sciences, Wiley.
4. Cox, P.R. (1978): Demography (Fifth Edition). Cambridge University Press.
5. David G. K., and Klein, M. (2008). Survival analysis - A Self-Learning Text, Second edition, Springer.
6. Lee, E. T., and Wenyu, J. (2003). Statistical methods for Survival Data Analysis, Third Edition, John Wiley & Sons.
7. Modelling Survivaldata in Medical Research, Second Edition (ISBN: 1-58488-325-1) by David Collett, Chapman & Hall/CRC, Boca Raton

6.1 STATISTICAL INFERENCE - II (Core)

L T P C
4 0 0 4

Preamble : To give the detailed idea of estimation, testing of hypothesis non parametric tests to the under graduate students.

Unit - I

Statistical hypotheses- simple and composite hypotheses-null and alternative hypotheses-critical region- two kinds of errors. Randomized and non-randomized tests -most powerful test- Neyman-Pearson lemma- simple problems. **(12L)**

Unit - II

Likelihood ratio test- tests for mean, equality of two means (independent samples),variance and equality of variances of normal populations. **(12L)**

Unit - III

Tests of significance: sampling distribution, standard error. Large sample tests concerning mean(s), variance(s), proportion(s) and correlation coefficient – simple problems. **(12L)**

Unit - IV

Tests of significance: Exact tests based on t, F and chi-square distributions concerning mean(s), variance(s), correlation coefficient(s)- Partial and multiple correlation coefficients. contingency table-test for goodness of fit and test for independence of attributes – simple problems. **(12L)**

Chi-square Tests: Tests for association, independence and goodness of fit.

Unit - V

Non-parametric tests – advantages and disadvantages of nonparametric tests- runs test, Kolmogorov -Smirnov test, sign test, median test, Mann-Whitney U test, and Wilcoxon's signed -rank test –simple problems and applications. **(12L)**

(Total: 60L)

BOOKS FOR STUDY:

1. Alexander M. Mood, Franklin A. Graybill, and Duane C. Boes (1974) Introduction to the Theory of Statistics (Third Edition), Mc Graw Hill Co., Ltd., New York.
2. Robert V. Hogg, Allen T. Craig (2012) Introduction to Mathematical Statistics (Fourth Edition), Macmillan Publishing Co., Inc., New York.
3. Goon, A. M., M.K. Gupta, and B. Dasgupta (2002) Fundamentals of Statistics, Vol. I, (Third Edition), World press Ltd, Kolkata.
4. Harold J. Larson (1982) Introduction to Probability Theory and Statistical Inference (Third Edition), John wiley & sons.Inc., New York.
5. Gupta, S.C., and V. K. Kapoor (1992) Fundamentals of Mathematical Statistics, A Modern Approach (Eighth Edition). Sultan Chand & sons, New Delhi.
6. Rice, J.A. (2007) Mathematical Statistics & Data Analysis (Third Edition), Thomos Brooks/colt, Singapore.
7. Edward J. Dudewicz, and Satya N. Mishra (1988) Modern Mathematical Statistics, John Wiley & Sons. Inc., New York.
8. Rohatgi, V. K. and A. K. md. Ehsanes Saleh (2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
9. Parimal Mukopadhyay (2006) Mathematical Statistics (Third Edition), Books and Allied Private Limited, Kolkata.

6.2 DESIGN OF EXPERIMENTS (Core)

L T P C
4 0 0 4

P0reamble : To focus on the design and analysis of variance techniques in the statistical field experiments.

Unit - I

Fundamental principles of experiments – randomization, replication and local control. Size of experimental units. Analysis of variance- one-way and two-way classifications.**(12L)**

Unit - II

Analysis of Variance and Basic Designs: Concept of Cochran's Theorem. Completely randomized design(CRD)- Randomized block design(RBD) - Latin square design(LSD) and their analysis - Missing plot techniques in RBD and LSD.   **(12L)**

Unit - III

Post ANOVA Tests: Multiple range test; Newman-Keul's test-Duncan's multiple range test-Tukey's test. Analysis of Covariance technique for RBD with one concomitant variable.   **(12L)**

Unit - IV

Factorial experiments: 2^2, 2^3 and 2^n factorial experiments. Definitions and their analyses.   **(12L)**

Unit - V

Principles of confounding –partial and complete confounding in 2^3– balanced incomplete block design(BIBD)– parametric relationship of BIBD.   **(12L)**

(Total: 60L)

BOOKS FOR STUDY:

1. Das, M.N. and Giri,N.C. (1988) Design and Analysis of Experiments(2nd Edition). New Age International, New Delhi.
2. Douglas,C. Montgomery(2012) Design and Analysis of Experiemnts. John Wiley & sons, New York.
3. Gupta, S. C. and V. K. Kapoor (1999) Fundamentals of Applied Statistics (Third Edition), Sultan Chand & Sons, New Delhi.
4. Dean, A and Voss (2006) Design and Analysis of Experiments. Springer India Private Limited, New Delhi.
5. Rangasamy, R (2010) A Textbook of Agricultural Statistics, New Age International Pvt Ltd.

6.3 OPERATIONS RESEARCH (Core)

L T P C
4 0 0 4

Preamble : To enable the students gain knowledge about various optimization techniques.

Unit - I
  Concepts of Operations Research – Limitations - Linear Programming Problem(LPP) - mathematical formulation of normal form - graphical solution. **(12L)**

Unit – II
  Simplex method – Big M method –Two-phase method – dual formulation. **(12L)**

Unit - III
  Transportation problem-mathematical formulation- North-West corner rule and Vogel's rule-MODI method - Assignment problem - Hungarian method. **(12L)**

Unit - IV
  Game theory: Maximin and Minimax criterion - saddle points-2×2 Games without saddle point- Dominance rule based on graphical method for $(2 \times n)$ and $(m \times 2)$ games. **(12L)**

Unit - V
  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.
                              (12L)
                           (Total: 60L)

BOOKS FOR STUDY:
1. Kanti Swarup, Gupta, P.K. and Man Mohan (2008) Operations Research (3rd Edition). Sultan Chand & Co, New Delhi.
2. Goel,B.S.and Mittal,S.K. (2000) Operations Research, PragatiPrakashan, Meerut.
3. Gupta, R.K.(1985) Operations Research, Krishna Prakashan, Mandir, Meerut.
4. Hillier, F.S and Lieberman, G. J. (1998) Operations Research, CBS Publishers and Distributors, New Delhi.
5. Kapoor, V.K. (2001), Operations Research, Sultan Chandan & Sons, New Delhi.
6. Sharma, J.K. (2001) Operations Research. Theory and applications, Macmillan, New Delhi.
7. Sharma J.K. (2002) Operations Research.Problems and solutions, Macmillan, New Delhi.
8. Taha, H.A. (2007) Operations Research – An Introduction (8th Edition) Prentice Hall of India, New Delhi.
9. Taha, H.A. (1996) Operations Research, 6/e, Prentice Hall,New Delhi

ELECTIVE - III

1. DISCRETE MATHEMATICS

LTPC
4 0 0 4

Preamble : To make the students get understanding sets, functions, logic and graph theory.

Unit - I

Sets and Relations: Introduction - Sets – Ordered pairs – Operations on Sets - Introduction to Relations – Binary relation – Classification of Relations – Composition of Relations –Inverse of Relation. **(12L)**

Unit - II

Functions: Introduction to Functions – Addition and Multiplication of Functions - Classifications of Functions – Composition of Function – Inverse Function. **(12L)**

Unit - III

Mathematical Logic: Introduction – Statement (Propositions)- Laws of Formal Logic- Basic Set of Logical operators/operations - Propositions and Truth Tables – Tautologies and Contradictions – Logical Equivalence – Logical Implication. **(12L)**

Unit - IV

Matrix Algebra: Introduction – Operations on Matrices – Symmetric and Skew-symmetric Matrices – Conjugate of a Matrix – Determinant of a Matrix – Adjoint and Inverse of a Matrix – Singular and Non-singular Matrices - Inverse of Matrices. **(12L)**

Unit - V

Graph: Introduction – Graph and Basic Terminologies – Types of Graphs – Sub Graph – Representation of Graph – Tree. **(12L)**

(Total: 60L)

BOOKS FOR STUDY:
1. Swapan Kumar Chakraborty and Bikash Kanti Sarkar (2014), Discrete Mathematics, oxford university press, UK.
2. Glory Ratna Mary and Y. S. Irine Viola, Mathematical foundations for computer science – part 1, Shekina publications.
3. Seymour Lipschutz and Marc Lars Lipson (2010), Discrete mathematics, third edition, Tata Mcgraw Hill education private limited, New Delhi.

2. RDBMS with ORACLE

L T P C
4 0 0 4

Preamble : To enable the students to learn the basic ideas of RDBMS and ORACLE.

Unit - I

Data Base Systems - Data models- Data Base Languages - Transaction - Storage Management – Data Base Administrator-Data Base Users - System Structure – Entity - Relationship Model. **(12L)**

Unit - II

Relational Model-Relational Algebra- Tuple and Domain Relational Calculus – extended Relational Algebra Operation-Relational Data Base Design- Decomposition – Normalization. **(12L)**

Unit - III

Oracle Architecture - Hardware Configuration - Logical and physical database layouts-SQL; DML, DCL, DDL Commands. **(12L)**

Unit - IV

Single-Group-Data-Character- Numeric-Conversion-Miscellaneous Functions-Set Operators and Joins-Sub queries-Data Base Objects: Views-Object views –synonyms-sequence and Index. **(12L)**

Unit - V

Introduction to PL/ SQL-Architecture of PL/ SQL Data types -Control Structures - Error handling - Procedures and Functions - Database Triggers. **(12L)**

(Total: 60L)

BOOKS FOR STUDY:
1. Abraham Silberschartz, Henry F. Korth and S. Sudharshan (1997) Database System Concepts (III Edition). McGraw-Hill, New York.
2. George Koch & Kevin Loney (1997) The Complete Reference (Third Edition), Tata McGraw Hill, New Delhi.
3. David McClanahan (1997) Oracle Developers Guide, Tata McGraw Hill Publishing House, New Delhi.
4. Desai, B. C. (1995) An introduction to Database Systems, Galgotia Publications Private Ltd., New Delhi.
5. Steve Bobrowski (1994) Mastering Oracle 7 and Client Server Computing (First Indian Edition) BPB Publications, New Delhi.