MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY

NAAC Accreditation Grade "B"

(With effect from Academic Year: 2017-18)

Academic Council: Date 26 / 04 / 2010, R. No.: (2)
Executive Council: Date 07 / 05 / 2010, R. No.: (3)

M.Sc.

Credit and semester system syllabus

NAME OF THE SUBJECT: STATISTICS

SEMESTER – 1st

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+ INT* = TOTAL	PASSING STANDARD EXT.+ INT* = TOTAL	TOTAL TEACHING HOURS	CREDITS
1	1	Linear Algebra.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
2	2	Distribution Theory.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
3	3	Inference – I (Theory of estimation)	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
4	4	Practical: Unit-1: Based on theory Paper – 1 Unit-2: Based on theory Paper-2 & 3	100 + 00 = 100	40 + 00 = 40	15 Weeks x 05 Hours = 75	12

*INTERNAL	Marks
1) ASSIGNMENT	10 Marks
2) SEMINAR	10 Marks
3) TEST	10 Marks
Total Marks:	**30 Marks**

M.Sc.

Credit and semester system syllabus

NAME OF THE SUBJECT: STATISTICS

SEMESTER – 2nd

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+ INT* = TOTAL	PASSING STANDARD EXT.+ INT* = TOTAL	TOTAL TEACHING HOURS	CREDITS
1	5	Probability and Stochastic processes.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
2	6	Inference – II (Testing of Hypothesis)	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
3	7	* Software tools & computing techniques relevant to Statistics	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
4	8	Practical: Unit – III: Based on Theory Paper-5 Unit – IV: Based on Theory Paper-6	100 + 00 = 100	40 + 00 = 40	15 Weeks x 05 Hours = 75	12

*INTERNAL	Marks
1) ASSIGNMENT	10 Marks
2) SEMINAR	10 Marks
3) TEST	10 Marks
Total Marks:	**30 Marks**

*** Updated in Academic Council: Dated: 30-05-2017, R.No. (07)**

M.Sc.

Credit and semester system syllabus

NAME OF THE SUBJECT: STATISTICS

SEMESTER – 3rd

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+ INT* = TOTAL	PASSING STANDARD EXT.+ INT* = TOTAL	TOTAL TEACHING HOURS	CREDITS
1	9	Multivariate Analysis.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
2	10	Linear Models and design of experiments.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
3	11	* Sampling Methods and Software tools.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
4	12	Practical: Unit – V: Based on Theory Paper-9 Unit – VI: Based on Theory Paper-10 & 11	100 + 00 = 100	40 + 00 = 40	15 Weeks x 05 Hours = 75	12

*INTERNAL	Marks
1) ASSIGNMENT	10 Marks
2) SEMINAR	10 Marks
3) TEST	10 Marks
Total Marks:	**30 Marks**

*** Updated in Academic Council: Dated: 30-05-2017, R.No. (07)**

M.Sc.

Credit and semester system syllabus

NAME OF THE SUBJECT: STATISTICS

SEMESTER – 4th

SR. NO.	PAPER NO.	NAME OF THE PAPER	TOTAL MARKS EXT.+ INT* = TOTAL	PASSING STANDARD EXT.+ INT* = TOTAL	TOTAL TEACHING HOURS	CREDITS
1	13	Mathematical Economics, Economic Statistics and Econometrics.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
2	14	Advanced Operations Research.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
3	15	Decision theory, Reliability and Industrial Statistics.	70 + 30 = 100	28 + 12 = 40	15 Weeks x 05 Hours = 75	05
4	16	Practical: Unit–V: Based on Theory Paper-13 & 15 Unit – VI: Based on Theory Paper-14	100 + 00 = 100	40 + 00 = 40	15 Weeks x 05 Hours = 75	12

*INTERNAL	Marks
1) ASSIGNMENT	10 Marks
2) SEMINAR	10 Marks
3) TEST	10 Marks
Total Marks:	**30 Marks**

Semester: I

Paper No. 1 - Linear Algebra **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Field, Vector spaces, subspace, linear dependence and independence of Vectors, orthogonal basis, vector spaces with an inner product, Gram-Schmidth orthogonolisation process, and orthonormal basis.	15	20
Units 2	Properties of rank, Rank of sum and product of matrices, Inverse of a matrix, Inverse of a partitioned matrix, Linear transformation, Solution of matrix equations, Algebra of matrices, Row and Column spaces of a matrix	15	20
Units 3	G-Inverse of a matrix and its properties, Method of computation G-Inverse, reflexive G-Inverse. Moore-Penrose G-Inverse and its properties	15	20
Units 4	Quadratic form, Semi definite, definite and indefinite Quadratic form, reduction to diagonal form, N-S condition for Quadratic form to be positive definite,Index and signature of Quadratic form, Hermite Canonical form, Hermition Matrices.	15	20
Units 5	Characteristic roots and vectors, Cayley-Hamilton theorem, Minimal polynomial similar matrices, algebraic and geometric multiplicity of characteristic root.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. C.R.Rao and Mitra (1980) : Generalized inverse of matrices and its application.
2. Searle S.R. (1982) : Matrix Algebra useful for statistics John Wiley and Sons.
3. C.R.Rao (1973) : Linear Statistics Inference and its applications, Wiley Eastern.

Semester: I

Paper No. 2 - DISTRIBUTION THEORY **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Brief review of basic distribution theory. Joint, marginal and conditional p.m. fs. Standard discrete and continuous distributions. Bivariate normal, multinomial distributions. Function of random variables and their distributions using Jacobian of Transformation and other tools. Characteristic functions, its properties, Inversion theorem, derivation of characterisitic function given the distribution and distribution function given the characteristic function.	15	20
Units 2	Distribution functions of a random variable and its properties. Power series distribution, generalized power series distribution, compounds distribution, contagious distributions, Neyman type A (NTA) distribution, poisson binomial distribution, poisson negative binomial distribution, Weibull distribution.	15	20
Units 3	Non-central sampling distributions: Non-central χ^2, t & f distribution and their properties. Quadratic forms in normal variables. Necessary and sufficient conditions for quadratic forms to be distributed as χ^2. Cochran's theorem. Joint distribution of the linear function from normal population sampling distribution of the correlation coefficient.	15	20
Units 4	Need of approximating distribution convergence of univariate and multivariate distribution functions, Slutsky's theorem the delta method and its application to function of sample moments, asymptotic distribution of functions of sample moments, transformation of statistics.	15	20
Units 5	Standard errors (small and large sample) of moments and related statistics. Order statistics, their distributions and properties, Joint and marginal distributions of order statistics. Asymptotic normality of sample quantities.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. David H.A.(1981): Order Statistics, Second edition John Wiley.
2. Rohatgi V.K.(1984): An introduction to probability theory and mathematical analysis, Wiley Eastern.
3. Johnson and Kotz(1972): Distribution in Statistics vol. I, II and III, John Wiley.
4. C..R.Rao (1973) Linear Statistical Inference and its applications, Second Edition, Wiley Eastern series.
5. Choudhary B. (1983): The elements of Complex Analysis, Wiley Eastern.
6. Kendall and Stuart: The advanced theory of Statistics Vol. I
7. Rohatgi V.K. (1984): Statistical inference, John Wiley.
8. Edward.J.Dudewicz and Satya.N.Mishra: Mathematical Statistics,Wiley Series in Wiley series in Probability and Statistics.
9. Feller W. (1966): Introduction to probability theory and its application Vol. II, Second edition, Wiley Eastern.
10. Luckas G.(1970): Characteristic functions, Criffin London.

Semester: I

Paper No. 3 - INFERENCE-I (THEORY OF ESTIMATION) **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Problem of statistical inference, point estimation, Consistency, Fisher Consistency, Unbiasedness, Efficiency. Invariance, Exponential family, location and scale family, Sufficiency, Complete Statistics. Estimation, Minimal sufficient statistics, Rao-Blackwell theorem.	15	20
Units 2	Completeness theorem, Lehmann Scheffe theorem, Fisher Information, Cramer-Rao inequality, Chapman-Robin inequality and Bhattacharya bounds (multiple extension in regular case only), Consistent Asymptotic Normal (CAN) Estimators.	15	20
Units 3	Methods of estimation (one or more parameters), Methods of moments, Method of Minimum Chi-square, Least squares. MLE, their properties, Consistent Asymptotic Normality of the consistent solutions of the likelihood equations. Identifiability of the consistent solution, Idea of asymptotic relative efficiency. Method of scoring for the estimation of the parameters.	15	20
Units 4	Idea of subjective probability, Prior and posterior distributions, Bayesian point and interval estimation based on the posterior distribution, Estimation under different loss functions like Squared loss funtion, Weighted squared loss function etc	15	20
Units 5	Theory of confidence intervals. Pivotal method, one and two sided confidence interval, shortest confidence intervals, Tolerance intervals, Ancillary information and its importance.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Lehman, E.L. (1983): Theory of point estimation. John Wiley and Sons.
2. Kale, B.K. (1999): A first course on parametric inference. Narosa publishing, New Delhi.
3. Zacks, S. (1971): Theory of Statistical inference. John Wiley and Sons.
4. C..R.Rao (1973): Linear Statistical Inference and its applications, Second Edition, Wiley Eastern.
5. Edward.J.Dudewicz and Satya.N.Mishra (1990) : Modern Mathematical Statistics, Wiley series in Probability & Statistics.
6. Ferguson, T.S. (1967): Mathematical Statistics: A decision theoretic approach Academic press.
7. Wilks, S. S.(1962): Mathematical Statistics. Wiley Eastern.
8. Goon, A.M., Gupta, M. and Dasgupta, B. (1980): An outline of Statistical theory- Vol. II. World press, Calcutta.
9. Box, G.E. P and G.C. (1973): Bayesian inference in Statistical Analysis. Adison Wesley.

Semester: I

Paper No. 4 – Practical **Credits: 12**

Marks: 100 Marks

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	1. Inverse of symmetric matrix by Do-little technique. 2. Solution of system of equations by finding inverse of the coefficient matrix and Gaussian elimination procedure. 3. Inverse by partition method. 4. Computation of G-inverse. 5. Computation of Moore-Penrose inverse. 6. Transformation of Quadratic form into diagonal form and finding rank, index and signature. 7. Computation of rank of a matrix by elementary transformation. 8. Consistent solution for the system of linear equations **AX=B**. 9. Gram-Schmidth procedure for orthogonalization of given vectors. 10. Linear dependence and independence set of vectors.	75	50
Units 2	1. Drawing of random samples from Poisson, Normal, Cauchy, Weibull and Exponential distributions. 2. Fitting of NTA distribution. 3. Fitting of Poisson-Binomial distribution. 4. Fitting of Weibull distribution by method of Maximum likelihood method. 5. Problem of Estimation: UMVUE, MLE with method of Scoring, MLE in truncated Distributions, Minimum Chi-Square, Bayesian point and interval Estimation, Standard errors of function of sample moments.	75	50

Semester: II

Paper No. 5 - PROBABILITY AND STOCHASTIC PROCESSES **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Classes of sets, field, Sigma-field, Minimal sigma field, Borel-Sigma field. Lim Superior and Lim Inferior of sets, Measure, Probability measure, properties of measure, Lebesgue and Lebesgue-Stieltses measure.	15	20
Units 2	Probability space, Induced probability space, distribution function on the real line with properties and correspondence theorem, Decomposition of DF. Random variable as a measurable function on the probability space, expectations and moments. Markov, Chebechev's, Holder's, Minkovski's and Jensen's inequalitities. Independence of sequence of events and random variables, Multiplication properties.	15	20
Units 3	Convergence of random variables, convergence in probability almost surely in the rth moment and in distribution, their relationships, Convergence of moments, Helly Bray theorem (only statement). Continuity theorem and convolution of distributions, Kintchins week law of large numbers, Kolmogrov inequality, Hajek-Reyni inequality (without proof), Strong law of large numbers, Central limit theorem; Lindberg-Levy and Liaponov forms of CLT with proofs.	15	20
Units 4	Definition of a Stochastic process, Classification of stochastic process according to state space and time space, Examples of occurrence of Stochastic Processes, Concept of weakly stationary and strong stochastic process. Chapman Kolmogorov's equations, Calculation of n-step transition probability and its limit. Stationary distribution, Classification of states. Transient Markov Chain.	15	20
Units 5	Random walk and Gambler's ruin problems, properties of irreducible chains. Time dependent Markov Process: Poisson Process, Birth Process, applications, Yule process, Birth and Death Processes. Application to storage problems. Application of these processes in biological, physical and social sciences.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Bhatt, B.R. (1984): Modern probability theory- An introductory text book, Second Edition. Wiley Eastern.
2. Feller, W. (1972): An introduction to probability theory and its applications. Vol-I and Vol-II. Wiley Eastern.
3. Rohatgi. V.K. (1979): An introduction to probability theory and Mathematical Statistics. Wiley Eastern.
4. Medhi. J. (1982): Stochastic Processes. Wiley Eastern.
5. Martin Eisen. (1969): Introduction to Mathematical Probability theory. Prentice Hall.
6. Burill C. W.(1972): Measure Theory and probability.
7. Parzen E. (1969): Modern probability theory and its applications. John Wiley.
8. Loeve M. (1957): Probability theory, III rd edition. Van Nostrand.
9. Ciniar E. (1975): Introduction to Stochastic Processes. Prentice- Hall.
10. Bartholomew D.J. (1982): Stochastic Processes, Holden-Day.
11. Parthasarathy K. R. (1977): Introduction to probability and measure, Mcmilan and Co.

Semester: II

Paper No. 6 - INFERENCE- II (TESTING OF HYPOTHESIS) **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Framing of null hypothesis, level of significance, size of test. Theory of hypothesis testing alternative hypothesis. Two kinds of error, simple and composite hypothesis, randomized test. Most powerful tests (MP-Tests). Neyman-Pearson lemma, Monotone likelihood ratio. Generalized Neyman-Pearson lemma (proof for sufficiency part only).	15	20
Units 2	Uniformly most powerful (UMP) Tests, UMPU tests, Boundedly Complete Statistics, similar regions, tests of Neyman structure. UMPU tests. Likelihood ratio test (LRT). Large sample properties, Consistency of tests, Asymptotic distribution of LRT, And examples based on LRT, Tests for one parameter exponential family, locally most powerful test. Confidence intervals and their connections with tests of hypothesis.	15	20
Units 3	Non- Parametric tests:U-Statistics, properties and empirical distribution function statement of Gliverko-Cantelly theorem. One sample problem: Goodness of fit, Kolmogrov - test, its consistency, Location problem – sign test and its optimality, confidence intervals for quantities. Wilcoxon Signed – rank test its consistency.	15	20
Units 4	Two Sample problem; Homogeneity – Kolmogrov-Smirnov test, and its consistency, run test. Location problem: Wilcoxon , Mann-Whitney test, Median test, Consistency and asymptotic normality Scale problem : Test for randomness run test.	15	20
Units 5	Need for sequential procedures, sequential tests, SPRT, properties of SPRT, Fundamental Identity of Wald O.C and ASN functions. Optimality examples for SPRT, approximate bound examples.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Lehmann E.L. (1986): Testing of statistical hypothesis second edition. John Wiley.
2. Wald A. (1947): Sequential analysis. Wiley Eastern
3. Zacks S. (1971): Theory of Statistical inference. Wiley
4. Kale B.K. (1999): A first course on Parametric Inference. Narosa Publishing, New Delhi.
5. Rao C.R. (1973): Linear Statistical Inference and its applications. second edition Wiley Eastern.
6. Kendall M.G. and Stuart A (1968): The advance theory of statistics, Vol-II, Charles Griffin and Co., London.
7. Wilks S.S. (1962): Mathematical Statistics, Wiley Eastern.
8. Puri M.L. and Sen P.K. (1971): Introduction to the theory of non-parametric statistics. John Wiley.
9. Radles D.A.S and Wolfe (1957): Non-parametric methods in statistics, John Wiley.
10. Fraser D.A.S (1957): Non-parametric methods in Statistics. John-Wiley
11. Govindarajulu (1957): Sequential Statistical procedures, Americal Science press, Columbus, Ohio.

Updated in Academic Council: Dated: 30-05-2017, R.No. (07)

M.Sc. (Statistics)
SEMESTER – II

Paper No.-7-Software Tools and Computing Techniques relevant to Statistics

Credits: 05

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed syllabus	Teaching Hours	Marks Weight
Units- 1	Data file and variable file in SYSTAT, different graphs in SYSTAT and EXCEL, Descriptive Statistics, Non Parametric Test –Kruskal Wallis Test, Kolmogrov Smirnov Test in SYSTAT	15	20
Units 2	Linear Regression, Bayesian Regression in SYSTAT.Non Parametric Test- Sign Test, Wilcoxon signed Rank Test.	15	20
Units 3	Uses of commonly available Statistical Package,Computation of correlation, sample generation of different distribution and other analysis of data on sample survey using available packages	15	20
Units 4	Analysis of variance: Estimate model, Hypothesis Test, Pairaise Computations in SYSTAT.Computation of multivariate regression model, time series data analysis.	15	20
Units 5	Hypothesis Testing, Test for mean, Tests for variance,Test for Crrelations, test for proportion in hypothesis testing.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text - Books / Additional Reading:

1. B.Rayan and B.L. Joiner (2001). Minitab, 4th edition, Duxbury.
2. R.A. Thisted (1988). Elements of statistical computing. Chapman and hall.
3. SYSTAT Manual , www.systat.com

Semester: II

Paper No. 7-SOFTWARE TOOLS AND COMPUTING TECHNIQUES RELEVENT TO STATISTICS

Credits: 05

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Windows: use of windows, its operations and applications. MS word: operations of MS word and applications.	15	20
Units 2	Data analysis software package: Spreadsheets; planning and creating spreadsheets; salient features and use of spreadsheets; for statistical analysis; presentation of graphics.	15	20
Units 3	Use of commonly available statistical package, MINITAB., Computation of regression, correlation, sample generation of different distribution and other analysis of data on sample survey using MINITAB.	15	20
Units 4	SYSTAT: uses of SYSTAT, computation of statistical problem using SYSTAT. Computation of .multivariate regression model, time series data analysis, robust regression model.	15	20
Units 5	Solving optimization problem using TORA- software. Introduction of some statistical packages. Technique of Web surfing and email.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. B. Ryan and B.L. Joiner (2001). Minitab Handbook, 4th edition, Duxbury.
2. R.A. Thisted (1988). Elements of statistical computing. Chapman and hall.
3. SPSS Manual BMP.

Semester: II

Paper No. 8 – Practical **Credits: 12**

Marks: 100 Marks

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	1. Probability of type I and type II errors and BCR. 2. Construction of MP, UMP and UMPU tests of hypothesis and drawing of power curves. Use of LRT in obtaining tests of certain hypothesis. 3. Construction of UMA, UMAU and shortest confidence intervals. 4. Non-Parametric tests. 5. SPRT, OC, ASN functions of Binomial, Poisson, Normal and Exponential Distribution. 6. Practicals based on Stochastic Process.	75	50
Units 2	Demonstration of the computer system. DOS commands practice on computer-spread creation, Business graphic data analysis. Use computer packages to analysis statistical problem; listed below Histogram, simple correlation and regression, Partial and multiple correlations, ANOVA for one way and two-way classification, analytical tests simulations. (i) Various algorithms in programming and related examples. (ii) Construction of difference tables. (iii) Use of Newton's Lagrange's and divide difference formulae. Solutions of a non-linear equation by the Newton Raphson's iterative formula. Computational method of solving difference and differential equations.	75	50

Semester: III

Paper No. 9 - MULTIVARIATE ANALYSIS **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Multivariate normal distributions, random sample from multivariate normal distributions, Singular and non-singular multivariate normal distributions, their marginal and conditional distributions of sample mean vector and sample dispersion matrix, Properties of multivariate normal distribution.	15	20
Units 2	Wishart distributions and its properties, M.L.E. of total partial and multiple correlation's and their null and non-null distributions, tests based on total partial and multiple correlation's. Simple examples.	15	20
Units 3	Tests on mean vectors for one and two multivariate normal populations. Hotelling T^2 and Mahalanobis D^2 and their null and non-null distributions. Properties and applications of T^2 and D^2. Related confidence regions.	15	20
Units 4	Multivariate linear models: Canonical reduction testing and illustration. Using L.R. Criterion UI(Union intersection) and step-down procedures under null hypothesis, exact non-null distribution of statistics involved in the test procedure and the asymptotic non-null distribution of these statistics. Canonical variates and Canonical correlations.	15	20
Units 5	Discrimination and Classification: Bayes procedure, L.R. procedure. Fisher's linear discriminator, Anderson's discriminator and discussion of their error properties as well as estimation of their error principal component analysis.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Johnson and Kotz(1972): Continuous multivariate Distribution, John Wiley.
2. Anderson T.W. (1983): An introduction to multivariate statistical analysis. Second Edition, John Wiley.
3. Kshirsagar A.M. (1972): Multivariate analysis, Marcel Dekker.
4. Rao C.R. (1973): Linear statistical inference and its applications, second edition, Wiley.
5. Mardia K.V., Kent J.T. and Bibby I.M. (1979): Multivariate analysis.
6. Srivastava M.S. and Carter E.M.(1983): An introduction to applied multivariate statistics, North-holland.
7. Morrison D.F. (1979): Multivariate statistical method, second edition, McGraw- Hill.

Semester: III

Paper No. 10 - LINEAR MODELS AND DESIGN OF EXPERIMENTS **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Linear model with assumptions error components, Estimability. BLUE for linear functions of parameters. Gauss Markoff's theorem. Unified theory of BLUE and least squares, Fisher Cochran theorem, Analysis of variance and covariance, simple examples.	15	20
Units 2	Block design, C-matrix and its properties, concept of connectedness, orthogonality. Balance and partial balance. Analysis of block design, Use of eigen values and eigen vectors and optimality in the sense of average variance and justification of missing plot techniques.	15	20
Units 3	BIBD – resolvability and parametric relations, Lattice and group divisible design. Youden square design, random block effects, recovery of interblock information in BIBD and youden square design. Efficiency of BIBD with RBD.	15	20
Units 4	Factorial experiments, concepts of confounding and balancing in symmetric factorial experiments, Construction and analysis of confounded symmetric factorial, construction and analysis concepts of resolution plans.	15	20
Units 5	PBIBD and parametric relations with two associate classes. Analysis of PBIB design. (Response surface experiments, first order design and orthogonal design). Construction of orthogonal latin squares and BIBD by method of finite geometry.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Das M.N. and Giri N. (1979): Design and analysis of experiments, Wiley Eastern.
2. C.R. Rao (1973): Linear statistical inference and its applications, Wiley Eastern.
3. Aloke Dey (1986): Theory of blocks design, Wiley Eastern.
4. Joshi D. D. (1973): Linear estimation and design of experiments, Wiley Eastern.
5. S.M.Shah and M.C. Jayswal: (Gujarati text book)

Updated in Academic Council: Dated: 30-05-2017, R.No. (07)

M.Sc. (Statistics)
SEMESTER – III

Paper No.-11- Sampling Methods and Software Tools Credits: 05

Marks: **100 Marks**

Marks: Semester End Examination: **70 Marks**

Continuous Internal Evaluation: **30 Marks**

Units	Detailed syllabus	Teaching Hours	Marks Weight
Units- 1	Varying probability sampling: PPS Sampling, estimation of population mean. Gain due to PPS sampling. Procedure of selecting PPS sampling (Cumulative total method and Lahiri's method), Horvits – Thompson estimator, its variance, variance estimators due to Horvitz - Thompson estimator under Yates and Grundy scheme.	15	20
Units 2	Two stage sampling: Estimation and sampling variance. Regression estimator: Bias and mean square error of the regression estimator, efficiency of regression estimator. Non sampling error.	15	20
Units 3	Ratio estimator: Bias and mean square error of the ratio estimation, estimation of bias and mean square error of the ratio estimator Unbiased of almost unbiased ratio type estimator. Product estimator.	15	20
Units 4	Robust regression: Least absolute deviation (LAD) regression, M regression, Least median square (LMS) regression, in SYSTAT	15	20
Units 5	Least Trimmed square (LTS) regression cluster analysis, Hierarchical clustering K- clustering, logistic regression in SYSTAT.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text - Books / Additional Reading:

1. Sukhatme P.V. et al. (1984): Sampling theory of surveys with applications, Indian Society of Agricultural statistics, New Delhi.
2. Singh and Choudhary (1989): Sampling theory, Wiley Estern.
3. Murthy M.M. (1967): Sampling theory and methods, Statistical publishing Society, Calcutta.
4. E. Balaguruswamy: Ansi-C.
5. Yashavant Kanetkar: :et us C, BPB Publications, NEW DELHI.
6. V.Rajaraman: Programming in C, Prentice-Hall New Delhi.
7. B. Rayan and B.L. Joiner (2001). Minitab Handbook, 4th edition, Duxbury.
8. R.A. Thisted (1988). Elements of statistical computing. Chapman and hall.
9. SPSS Manual BMP.
10. Denis Ritchie and Kermigham: C- programming.
11. Des Raj(1976): Sampling theory. Tata McGraw – Hill.
12. Lesie Kiss (1984): Survey Sampling, John Wiley and Sons.

Semester: III

Paper No. 12 – Practical **Credits: 12**

Marks: 100 Marks

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	1. Simulating data from multinomial and other distributions. 2. Random sample from trivariate distribution. 3. Estimate of mean and variance-covariance matrix from multivariate normal distribution. 4. Hotelling T^2 and Mahalanobis D^2 statistics and their use in testing of hypothesis on mean vectors. 5. Construction of simultaneous confidence intervals. 6. Fisher's linear discriminate and Bayes rule with associated probabilities of misclassification. 7. Test on Partial, Multiple and Regression coefficients. 8. Canonical correlation and Canonical variates and Principal components. 9. Problem on LR tests. 10. PPSWR and PPSWOR, cumulative total method and Lahiri's method. 11. Stratified random sampling. 12. Systematic Sampling. 13. Ratio and Regression method of estimation. 14. Two stage sampling. 15. Programming problems with C, various statistical programs.	75	50
Units 2	1. Problem in linear model with assumption on error, components condition for estimability BLUE for linear functions of parameters. 2. Analysis of BIBD – Intra block and with recover or Inter block information resolvable BIBD and Youden square design Analysis of BIBD. 3. Construction of Latin square, Orthogonal Latin square & BIBD design. 4. Construction of Confounded factorial design	75	50

Semester: IV

Paper No. 13 - Mathematical Economics, Economic -Statistics And Econometrics **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Market equilibrium price and demand and their interpretation. Geometrical effect of taxation on market equilibrium, effect of taxation on monopoly. Edge worth's paradox. Effect of tax on two-commodity curve of demand when elasticity of demand is constant. Partial elasticity of demand. Engel's law. Income elasticity of demand. Marginal cost of elasticity of cost. Production of two commodities monopoly. Duopoly problems.	15	20
Units 2	Average product, Marginal product, Utility index and budget equation. Elasticity of productivity constant. Elasticity of substitution function. Substitution of factors and elasticity of substitution. Homogeneous production functions. Special study of Cobb-Douglass production function. Input-Output analysis. Leontief's inter-industry relations, extended Leontief's closed system and its uses in other fields.	15	20
Units 3	Time series data and Cross-section data. Analysis of Time Series. Components of time series: Trend, Seasonal, Cyclical and Random Components and methods of their elimination. Spectral decomposition and distribution function, Periodogram and Correlogram, Autoregressive series.	15	20
Units 4	Aitkin's Generalized least square (GLS) estimator. Heteroscedasticity, test for Homoscedasticity. Autocorrelation, test for autocorrelation; Multicollinearity, tools for handling Multicollinearity. Linear regression with stochastic regressors, Errors in variable models and instrumental variable estimation, independent stochastic linear regression, Distributed lag models.	15	20
Units 5	Simultaneous linear equation models: Structural equation models, identification problem, rank and order conditions. Single equations and simultaneous equations. Methods of estimation: Indirect least square and two stage least squares method.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Theil H.(1971): Principles of econometrics, John Wiley.
2. Klien L.R. (1962): An introduction to econometrics. Prentice – Hall of India.
3. Allen R.G.D.(1979): Mathematical Analysis of econometrics.
4. Johnston J. (1984): Econometric methods – 3rd edition. McGraw-Hill.
5. Kendall M.G. and Stuart A. (1968): Advanced theory of Statistics –Vol3, Charles Griffin & Co. London.
6. Gujarati D. (19): Econometrics.
7. Searle S.R. (1971): Linear Statistical models, John Wiley and Sons.
8. Allen, R. G. D. (1971): Mathematical Economics, McGraw – Hill.

Semester: IV

Paper No. 14 - Advanced Operations Research **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Definition and scope of different types of models, General method of solution, Review of Linear programming problems. Method of solution, Duality theorem, Artificial variable method, Two-phase method, Big-M method. Revised Simplex algorithm, problem of degeneracy.	15	20
Units 2	Transportation problem, Assignment problem with example. Branch and bound algorithm. Traveling salesmen problem. Introduction to Networks, Determination of flows and Critical paths, PERT. Sensitivity analysis.	15	20
Units 3	Elementary inventory models with and without restriction, deterministic and probabilistic models. Queuing theory. Introduction of stationary states of M/M/1 queues. M/M/C queues with applications and simple examples.	15	20
Units 4	Games in normal and extended forms, fundamental theorem of matrix games. Solution of 2x2, 2xm and mxn zero sum games by dominance principle. LP representation and graphical method. Sequencing and Scheduling models. 2- machine n-job problem(no passing). 3-machine n-job problems, different routing: 2-job and m-stations.	15	20
Units 5	Non-linear programming: Kuhn-Tucker theorem. Wolfe's and Beal's algorithm for solving quadratic programming problems. Bellman's principle of optimality. General formulation. Computational methods and application of dynamic programming	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Taha H.A.: Operations research-6th edition, Prentice – Hall, New Delhi.
2. Kanti Swarup and Gupta M. M.(1985): Operations Research, Sultan Chand & Co.
3. Hadley G.(1964): Non-linear programming and Dynamic programming. Addison- Wesley.
4. Churchman C.W., Ackoff R.L. and Arnoff E.L. (1967): Introduction to Operations Research.
5. Rao S. S. (1978): Optimization theory and applications – 2nd edition. Wiley Eastern.
6. Hadley G. and Whitin T.M. (1963): Analysis of Inventory systems. Prentice –Hall, New Delhi.
7. Memhuser G.L. (1966): Introduction to Dynamic programming. John Wiley.
8. R. Pannerselvam: Operations Research, Prentice – Hall, New Delhi.

Semester: II

Paper No. 15 - Decision Theory, Reliability And Industrial Statistics **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Decision problems and two person zero sum game, problem of inference Viewed as a decision problem. Non-randomized decision rules, admissibility, complete Class and essentially complete classes. Squared error loss, Absolute error loss, Convex loss function and risk function.	15	20
Units 2	Bayes principle, determination of Bayes rule, admissibility of Bayes rule, extended and generalized Bayes rules. Existence and complete class theorem for Bayes solution. Minimax principle with finite parameter space only. Bayes solution, minimax equalizer rules, determination of minimax rule and their relationship with Bayes solution.	15	20
Units 3	Reliability concepts and measures, Components and systems, cuts and paths. Life distributions, survival functions, hazard rate, hazard function, residual lifetime survival function, residual; lifetime. Mean residual life function, one–to-one correspondence of these functions, common life distributions, exponential, weibull, gamma, lognormal, Pareto etc.	15	20
Units 4	Parametric inference for various life distributions, Maximum Likelihood estimation and moments, tests based on MLE/Rao & Wald Technique. Type-1 and Type-2 censoring schemes with and without replacement. Likelihood functions based on these sampling schemes, estimation and testing based on these schemes for various parametric models. Reliability estimation based on failure times.	15	20
Units 5	General concept of acceptance sampling plans: Single and Double sampling inspection plan for attributes (with and without curtailment) when the two points are fixed on the OC curve. Sequential Sampling Plans. Sampling inspection plans for variable when two points are fixed on OC curves. Single sampling plans for variable with known and unknown standard deviation with (1) Lower limit specified and (2) Upper limit specified. Application of SPC techniques in Industry.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Montegomory D. C. (1985): Introduction of Statistical quality control, John Wiley
2. Miller R. G. (1981): Survival Analysis.
3. Barlow R. W. and Pros Chan F.(1965): Mathematical Reliability. John Wiley.
4. Barlow R. W. and Pros Chan F. (1975): Statistical theory of Reliability and life testing, Holt-Rinehart and Winston.
5. Berger. J. O. (1989): Statistical decision foundations: Concepts and methods.
6. Springer- Verlag.
7. Lawlwss J. E. (1982): Statistical models and methods of life time data, John Wiley.
8. Bain L. J. and Engelhardt M. (1982): Statistical analysis of reliability and life testing models. Marcel-Dekker.
9. Ekambaram S.K.: The Statistical basis of acceptance sampling. Asia Publishing house, Bombay.
10. Zacks S: Introduction to reliability analysis: Probability models and Statistical methods, Springer-Verlag, New York, Inc.

Semester: IV

Paper No. 16 – Practical **Credits: 12**

Marks: 100 Marks

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	(1) Utility and Budget equation; amount of factors and profit maximization. (2) Fitting of Cobb-Douglas production function, Input Output analysis. (3) (I) Methods of elimination of trend time series data, weighted moving average method, Spencer's 15 point and 21 point formula. Variate difference method, Trend ratio method and link relative method. (II) Fitting of Auto regressive time series data, Periodogram and Correlogram analysis. (4) Problems in linear models with associated tests. Confidence intervals and prediction. Autocorrelation; Durbin-Watson test, method of instrumental variable, use of method of indirect least squares in estimation of parameters of simultaneous equations models, method of two stage least squares, Identification problems. (5) Solution of LPP by simplex and revised simplex methods. Duality, Transportation and Assignment problems. Branch and bound technique, inventory problems, Problems based on Network analysis and PERT.	75	50
Units 2	(1) Life Distributions: Fitting of weibull, Gamma and Exponential. Parametric Inference for various life distributions. Moments and MLE. Type-I and Type – II and random censoring schemes. (2) OC curve for $\overline{X}$ and R-Charts. OC, ASN and AOQ curves for double and Curtailed sampling plans for attributes, sampling plan for variables.	75	50

MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY

NAAC Accreditation Grade "B"

(With effect from Academic Year: 2017-18)

LIST OF COURE PROPOSED TO BE OFFERED AS CHOICE BASED INTER DISCIPLINARY COURSES TO THE REGULAR STUDENTS REGISTERED IN OTHER PG DEPRTMENT

(w.e.f. Academic Year commencing from June 2010)

Faculty: Science
Subject: Statistics
PG Department: Statistics

Sr. No.	Semester	Course Title	Eligibility	Remarks
IDC I	I	Linear Algebra.	M.Sc. (Mathematics, Physics, Chemistry)	
IDC II	II	Data Analysis	M.Sc. (Any Science Stream)	
IDC III	III	Biostatistics	M.Sc.(Life Science, Marine Science, Chemistry, Pharmacy, Medical)	
IDC IV	IV	Statistics for Economists	M.A. and M.Com (With Economics)	
IDC V	IV	Advanced Operations Research.	M.Sc. (Mathematics, Physics)	

Semester: I

Paper No. IDC I: Linear Algebra **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Field, Vector spaces, subspace, linear dependence and independence of Vectors, orthogonal basis, vector spaces with an inner product, Gram-Schmidth orthogonolisation process, and orthonormal basis.	15	20
Units 2	Properties of rank, Rank of sum and product of matrices, Inverse of a matrix, Inverse of a partitioned matrix, Linear transformation, Solution of matrix equations, Algebra of matrices, Row and Column spaces of a matrix	15	20
Units 3	G-Inverse of a matrix and its properties, Method of computation G-Inverse, reflexive G-Inverse. Moore-Penrose G-Inverse and its properties	15	20
Units 4	Quadratic form, Semi definite, definite and indefinite Quadratic form, reduction to diagonal form, N-S condition for Quadratic form to be positive definite,Index and signature of Quadratic form, Hermite Canonical form, Hermition Matrices.	15	20
Units 5	Characteristic roots and vectors, Cayley-Hamilton theorem, Minimal polynomial similar matrices, algebraic and geometric multiplicity of characteristic root.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. C.R.Rao and Mitra (1980) : Generalized inverse of matrices and its application.
2. Searle S.R. (1982) : Matrix Algebra useful for statistics John Wiley and Sons.
3. C.R.Rao (1973) : Linear Statistics Inference and its applications, Wiley Eastern.

Semester: II

Paper No. IDC II - Data Analysis **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Sampling procedure – determination of sample size and selection of sample formation of questionnaire – structured and unstructured questionnaire. Field work – Execution of survey – data collection, scaling techniques – Guttman scale – Likert 5 points scale.	15	20
Units 2	Summarizing data – tabulation – averages – dispersions – measurement of risk – relative measures of dispersion – efficiency and consistency – comparision of two ormore populations – large sample test, small sample test ANOVA – Application of Statistical packages.	15	20
Units 3	Association of attributes: Chi –square test – correlation – rank difference correlation/ biserial correlation, point biserial correlation. Significance of correlation, rank correlation and biserial correlation coefficient,partial and multiple correlations. Significance of multiple regression eauation – significance of bo,bl..bn the linear regression coefficient – application of statistical packages.	15	20
Units 4	Non – Parametric tests: Tests for randomness, Run test, Sigh test and Mann Whitney U test. Wilcoxon Signed rank test. Median test - statistical packages.	15	20
Units 5	Curve Fitting – Curves of type Y = a+bx+cx2 Y = abx Y = a+bx+cx Y = a.ebx Time series – estimates of trend and seasonal variation – forecasting – statistical packages.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Siegel, S and Castellan, NJ (1988) : Non – Parametric statistics for behavioral science McGraw Hill Book Co, NewYork.
2. Srivastava UK, Shenoy GC and Sharma SC (1989): Quantitative Techniques Managerial Decision Wiley Eastern, new delhi.
3. A.Koutsoyians (1977): Theory of Econometrics. The MacMillon press Ltd.
4. V.K.Kapoor and SC Gupta, (1986) : Fundamentals of Mathematical Statistics , Sultan Chand and sons, New Delhi.
5. Garrett Henry E, (1973): Statistics in Psycology and Education. Vakils, Feffer and Simons Pvt. Ltd.
6. Hoel Paul G 1957: Introduction to Statistics, Asia Publishing Housing Pvt. Ltd, New Delhi.
7. Kothari CR (1984): Quantative Techniques, Vikas Publishing House (P) ltd, New Delhi.
8. Kothari CR (1990): Research Methodology, Wiley Eastern Ltd, new Delhi.

Semester: III

Paper No. IDC III – Biostatistics **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Nature of biological and clinical experiments and data – classification of data –Need for and nature of tabulation – charts and diagrams for data – Bar diagram, Pie diagrams, Pictograms, Histograms – frequency curves and their uses.	15	20
Units 2	Measures of Central Tendency – Mean, Median, Mode, Geometric Mean, Use of these averages in biological studies. Measures of deviation and Standard deviation - Coefficient of variation – Measure of skewness and kurtosis.	15	20
Units 3	Correlation and regression theory – Correlation coefficient – rank correlation – Regression equations (only Problems) – Multiple and partial correlation and regression. Basic Concepts of sampling- Simple random sample, Stratified sample- Systematic samples.	15	20
Units 4	Test of Significance based on large samples - test for mean, variance, proportions- test for mean, variance and attributes using, t, f and Chi – square distribution- test for correlation, regression coefficients, Chi – square test for goodness of fit.	15	20
Units 5	Analysis of Variance: One way and Two way classifications – Completely randomized Blocks – Randomized Block design and Latin Square design (Sample problems based on biological and biochemical data).	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Sundar Rao, Jesudian, Richard – An Introduction to Biostatistics.
2. Alvi E Lewis – Biostatistics – East West Press.
3. S.P.Gupta – Fundamentals Statistical Methods – Sultan Chand.
4. Campbell – Statistics for Biologist.

Semester: IV

Paper No. IDC IV - Statistics for Economists **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Market equilibrium price and demand and their interpretation. Geometrical effect of taxation on market equilibrium, effect of taxation on monopoly. Edge worth's paradox. Effect of tax on two-commodity curve of demand when elasticity of demand is constant. Partial elasticity of demand. Engel's law. Income elasticity of demand. Marginal cost of elasticity of cost. Production of two commodities monopoly. Duopoly problems.	15	20
Units 2	Average product, Marginal product, Utility index and budget equation. Elasticity of productivity constant. Elasticity of substitution function. Substitution of factors and elasticity of substitution. Homogeneous production functions. Special study of Cobb-Douglass production function. Input-Output analysis. Leontief's inter-industry relations, extended Leontief's closed system and its uses in other fields.	15	20
Units 3	Time series data and Cross-section data. Analysis of Time Series. Time series - Concept - Components of time Series - Additive and multiplicative models - Measurement of trend - Moving average method - Least square method Components of time series: Trend, Seasonal, Cyclical and Random Components and methods of their elimination. , Measurement of seasonal variations - Simple average method - Ratio to trend method - Ratio to moving average method - Link relative method - Variate Difference method.	15	20
Units 4	Autoregressive series and its applications Aitkin's Generalized least square (GLS) estimator. Heteroscedasticity, test for Homoscedasticity. Autocorrelation, test for autocorrelation; Multicollinearity, tools for handling Multicollinearity. Graphical representation of time series data and its applications.	15	20
Units 5	Index Numbers - uses, classification of index numbers - Problems in the construction of index numbers - Methods of constructing index numbers - Unweighted index numbers - weighted index numbers. Quantity index numbers - Fixed and chain base index numbers - Optimum test for index numbers - Time reversal test - factor reversal test - cost of living index numbers. Applications of Cost of living Index Numbers- Deflating.	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: **30 Marks**

Reference / Text – Books / Additional Reading:

1. Theil H.(1971): Principles of econometrics, John Wiley.
2. Klien L.R. (1962): An introduction to econometrics. Prentice – Hall of India.
3. Allen R.G.D.(1979): Mathematical Analysis of econometrics.
4. Johnston J. (1984): Econometric methods – 3rd edition. McGraw-Hill.
5. Kendall M.G. and Stuart A. (1968): Advanced theory of Statistics –Vol3,
6. Charles Griffin & Co. London.
7. Gujarati D. (19): Econometrics
8. Searle S.R. (1971): Linear Statistical models, John Wiley and Sons.
9. Allen, R. G. D. (1971): Mathematical Economics, McGraw – Hill.

Semester: IV

Paper No. IDC V - Advanced Operations Research **Credits: 05**

Marks: **100 Marks**
Marks: Semester End Examination: **70 Marks**
Continuous Internal Evaluation: **30 Marks**

Units	Detailed Syllabus	Teaching Hours	Marks/ Weight
Units 1	Definition and scope of different types of models, General method of solution, Review of Linear programming problems. Method of solution, Duality theorem, Artificial variable method, Two-phase method, Big-M method. Revised Simplex algorithm, problem of degeneracy.	15	20
Units 2	Transportation problem, Assignment problem with example. Branch and bound algorithm. Traveling salesmen problem. Introduction to Networks, Determination of flows and Critical paths, PERT. Sensitivity analysis.	15	20
Units 3	Elementary inventory models with and without restriction, deterministic and probabilistic models. Queuing theory. Introduction of stationary states of M/M/1 queues. M/M/C queues with applications and simple examples.	15	20
Units 4	Games in normal and extended forms, fundamental theorem of matrix games. Solution of 2x2, 2xm and mxn zero sum games by dominance principle. LP representation and graphical method. Sequencing and Scheduling models. 2- machine n-job problem(no passing). 3-machine n-job problems, different routing: 2-job and m-stations.	15	20
Units 5	Non-linear programming: Kuhn-Tucker theorem. Wolfe's and Beal's algorithm for solving quadratic programming problems. Bellman's principle of optimality. General formulation. Computational methods and application of dynamic programming	15	20

Break up of Continuous Internal Evaluation:

1. ASSIGNMENT 10 Marks
2. SEMINAR 10 Marks
3. TEST 10 Marks

Total Marks: 30 Marks

Reference / Text – Books / Additional Reading:

1. Taha H.A.: Operations research-6th edition, Prentice – Hall, New Delhi.
2. Kanti Swarup and Gupta M. M.(1985): Operations Research, Sultan Chand & Co.
3. Hadley G.(1964): Non-linear programming and Dynamic programming. Addison-Wesley.
4. Churchman C.W., Ackoff R.L. and Arnoff E.L. (1967): Introduction to Operations Research.
5. Rao S. S. (1978): Optimization theory and applications – 2nd edition. Wiley Eastern.
6. Hadley G. and Whitin T.M. (1963): Analysis of Inventory systems. Prentice –Hall, New Delhi.
7. Memhuser G.L. (1966): Introduction to Dynamic programming. John Wiley.
8. R. Pannerselvam: Operations Research, Prentice – Hall, New Delhi.