Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)

Course Structure for M.Sc.- I Semester- II (STATISTICS)

Semester	Paper Code	Title of Paper	No. of Credits
II	STAT-4201	Probability Theory	4
	STAT-4202	Parametric Inference	4
	STAT-4203	Multivariate Analysis	4
	STAT-4204	Regression Analysis	4
	STAT-4205	Practical-III	4
	STAT-4206	Practical-IV	4

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4201
Paper : I Title of Paper : Probability Theory
Credit : 4 credits No. of lectures : 60

TOPICS/CONTENTS:

Unit-1

Review of algebra of sets, sequence of sets, limsup, liminf and limit of a sequence of sets, Classes of sets, field, sigma field, minimal sigma field, Borel fields, measurable space, monotone classes, Measurable function, Real and Vector valued random variables, simple r.v., r.v. as a limit of sequence of simple r.v.s, Probability measure on a measurable space, probability space, properties of probability measure: continuity, mixture of probability measures, Lebesgue and Lebesgue-Steltjes measures. **(18L)**

Unit 2

Distribution function, decomposition of a distribution function, discrete and continuous type r.v., Correspondence theorem (without proof), Expectation of simple r.v, non-negative r.v. and arbitrary r.v., properties of expectation, moments, moment inequalities. **(12L)**

Unit 3

Convergence of a sequence of r.v.s, convergence in probability, convergence in distribution, convergence in r^{th} mean, almost sure convergence, their inter-relations, Slutkey's theorem, convergence theorem for expectations, characteristic function and properties, conjugate pairs of distributions, uniqueness theorem (without proof) **(15L)**

Unit 4

Independence of events, class of independent events, independence of classes, independence of r.v's, expectation of the product of independent r.v.'s, equivalent definitions of independence, Kolmogorov 0-1 Law, Borel 0-1 criterion, Borel Cantelli Lemma, Khintchin's WLLN, Strong Law of Large Numbers (SLLN) (Statement only), Central Limit Theorem (CLT), Levy continuity theorem, CLT for i.i.d. r.v.s, Liaponove's form, Lindeberg Feller form and their applications. **(15L)**

REFERENCES:

1) Bhat, B.R. (2007) Modern Probability Theory, Third Edition. New Age Inter-national
2) Billingsley, P. (1995) Probability and Measure, Wiley Publication.
3) Chung, K. L. (2001) A Course in Probability Theory, Third Edition, Academic Press, London
4) Basu, A. K. (1999) Measure Theory and Probability (Prentice Hall of India)
5) Ash, Robert. (1972) Real Analysis and Probability, (Academic Press)
6) Feller, W. (1969) Introduction to Probability and its applications Vol.II, (Wiley Easter Ltd.)
7) Gut A. (2005), Probability: A Graduate Course, Spinger-Verlag, New York.

8) Dasgupta A. (2008), Asymptotic Theory of Statistics and Probability, Spinger-Verlag, New York.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4202
Paper : II Title of Paper : Parametric Inference
Credit : 4 credits No. of lectures : 60

TOPICS/CONTENTS:

Unit-1

Sufficiency, Fisher's concept of sufficiency, Sufficient statistic, Factorization theorem, Joint Sufficiency, Likelihood Equivalence, Minimal Sufficiency, construction of Minimal Sufficient Statistic, Exponential family and Pitman family admitting Minimal Sufficient Statistic. **(15L)**

Unit 2

Fisher information for one parameter and several parameter models, Unbiasedness, Estimable function, Best Linear Unbiased Estimator, Gauss-Markov theorem, Cramer Rao inequality and its application, Rao-Blackwell theorem, Completeness, Lehman-Scheffee theorem and its application, necessary sufficient condition of MVUE, Ancillary statistic. **(15L)**

Unit 3

Critical region and test function, Neyman Pearson lemma and Most Powerful test, Uniformly Most Powerful (UMP) test for one sided alternative for one parameter Exponential class of density and extension to the distribution having Monotone Likelihood Ratio property, statement of UMPU test. **(15L)**

Unit 4

Confidence Interval (C.I.), Shortest Expected Length C.I. Uniformly Most Accurate C.I., introduction to Bayesian estimation: Prior and Posterior distribution, Loss function, Conjugate family of Prior distribution and its example, Principal of Minimum Expected Posterior Loss. **(15L)**

REFERENCES:

1. Casella G. and Beregar R.L. (2002) Statistical Inference, 2nd Edition (Duxbury Advanced Series)
2. Dudewitz E.J. & Mishra S.N.(1988) Modern Mathematical Statistics (John Wiley)
3. Kale B.K. (1999) A First course on Parametric Inference (Narosa)
4. Lehman E.L (1988) Theory of point estimation (John Wiley)
5. Lehman E.L(1986) Testing of Statistical hypotheses (John Wiley)

6. Rohatagi V.K. (1976) Introduction to theory of probability & mathematical statistics (John Wiley & sons)
7. Dasgupta A. (2008), Asymptotic Theory of Statistics and Probability, Spinger-Verlag, New York.

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4203
Paper : III Title of Paper : Multivariate Analysis
Credit : 4 credits No. of lectures : 60

TOPICS/CONTENTS:

Unit-1

Exploratory multivariate data analysis, sample mean vector, sample dispersion matrix, correlation matrix, graphical representation, linear transformation and its mean, variance covariance, correlation between linear transformations, principal component analysis, factor analysis, canonical correlation with applications, cluster analysis with applications. **(20L)**

Unit 2

Multivariate normal distribution, singular and non-singular normal distribution. m.g.f., characteristic function, moments, distribution of a linear form and quadratic form of normal variables, Cochran theorem, marginal and conditional distribution. Test for multivariate normality. **(12L)**

Unit 3

M.L.E's of parameters of multivariate normal distribution and their sampling distribution, Wishart matrix, Wishart distribution and its properties, Tests of hypothesis about mean vector of a multivariate normal population, Hotelling T^2 statistic and its distribution, its applications. Likelihood ratio test, confidence region for mean vector of multivariate normal distribution.

(15L)

Unit 4

Test for equality of dispersion matrices, discriminant analysis, Mahalanobis D^2 statistic, test for significance of the coefficients in discriminant function, misclassification error, methods and applications of MANOVA (without derivation of the distribution of Wilk's lambda). **(13L)**

REFERENCES

1. Anderson T.W.(1984) Introduction to multivariate analysis (John Wiley)
2. C. R. Rao (1985) Linear Statistical inference and its applications (Wiley Eastern Ltd)
3. Hardle, W. K. & Simar, L. (2012) , Applied Multivariate Statistical analysis (Springer, New York)Johnson R.A. and Wichern D.W.(1988)Applied multivariate statistical analysis (Prentice hall Inc.)

3. Johnson R.A. & Wichern, D.W. (1988). Applied Multivariate Statistical analysis (Prentice Hall Inc.)
4. Kshirsagar A.M. (1983) Multivariate Analysis(Marcel Dekker.)
5. K.C. Bhuyan (2005) Multivariate Analysis and its application, New Central book agency, LTD. Kolkatta
6. Morrison, D.F.(1990). Multivariate Statistical Methods (McGraw Hill Co.) (3rd ed.)

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4204
Paper : IV Title of Paper : Regression Analysis
Credit : 4 credits No. of lectures : 60

TOPICS/CONTENTS:

Unit-1

Simple linear regression, assumptions, least square (LS) estimators of parameters, standard error of estimators, testing of hypothesis for coefficient of regression, S.E. of prediction, testing of hypothesis about parallelism (slopes), equality of intercepts, generalized and weighted least squares, congruence, extrapolation, optimal choice of independent variables diagnostics checks and correction: graphical technique, tests for normality, uncorrelatedness, homoscadasticity, lack of fit, transformation on of dependent or independent variables. **(15L)**

Unit 2

Multiple regression: Standard Gauss-Markov setup, least square estimation, error and estimation spaces, variance and covariance of LS estimators, properties of LS estimators, estimation of error variance, case with correlated observation, LS estimation with restriction on parameters, simultaneous estimation of linear parametric functions, testing of hypothesis for one and more than one linear parametric functions, confidence intervals and regions, generalized and weighted least squares, Mallows Cp, stepwise regression methods – forward, backward, stepwise. **(15L)**

Unit 3

a) Multicollinearity: consequences, detection and remedies, autocorrelation consequences, Durbin Watson test, estimation of parameters in autocorrelation.**(4L)**

b) Multiple correlation, adjusted multiple correlation coefficient, null distribution of simple correlation and multiple correlation coefficient, partial correlation coefficient

and its relation with multiple correlation coefficient, test for significance of simple, multiple and partial correlation coefficients. Residual and residual diagnostics, transformation of variables: Box-Cox power Transformation. **(11L)**

Unit 4

a) Polynomial regression, inverse regression, Non-linear regression: Non-linear least squares transformation to a linear model, their uses and limitations, examination of non-linearity, initial estimates, iterative procedure, Newton-Raphson method. **(5L)**

b) Generalized linear model: Link function: normal, binomial, Poisson, exponential, gamma. **(3L)**

c) Logistic regression: Logit transform, ML estimation, tests of hypothesis, Wald test, LR test, score test, test for overall regression. **(7L)**

REFERENCES

1. Draper, N. R. and Smith H. (1998) Applied regression analysis 3rd edition (John Wiley)
2. Hosmer, D. W. and Lemeshow, S. (1989) Applied logistic regression (John Wiley)
3. McCullagh, P. and Nelder, J. A.(1989) Generalized linear models (Chapman and Hall)
4. Montogomery D.C.,Elizabeth a. Peck, G.Geoffrey.(2003) Introduction to linear regression analysis (Wiley Eastern)
5. Neter, J.; Wasserman, W. and Kutner, M.H.(1985) Applied linear statistical models
6. Ratkowsky, D. A.(1983) Nonlinear regression modeling (Marcel Dekker)

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4205
Paper : V Title of Paper : Practical-III
Credit : 4 credits No. of lectures : 60

Sr. No.	Title of Experiments
1.	Exploratory multivariate data analysis
2.	Principal component analysis
3.	Factor Analysis
4.	Canonical correlation analysis
5.	Cluster Analysis
6.	Visualizations in multivariate data
7.	Model sampling from multivariate normal distribution and computation of M.L.E.'s of parameters
8.	Model sampling from Wishart distribution.
9.	Application of Hotelling T^2 statistics I
10.	Application of Hotelling T^2 statistics II
11.	Likelihood ratio tests (Multivariate Test)
12.	Discriminant analysis
13.	Multivariate Analysis of Variance
14.	Computation of power of the test and level of significance
15	Computation of confidence coefficient for given confidence interval

SYLLABUS (CBCS) FOR M.Sc.-I Sem.-II STATISTICS

(With effect from Academic Year 2019-2020)

Paper Code : STAT-4206
Paper : VI Title of Paper : Practical-IV
Credit : 4 credits No. of lectures : 60

Sr. No.	Title of Experiments
1.	Simple regression and regression diagnostic I
2.	Multiple regression
3.	Lack of fit of the regression model
4.	Multiple regression (selection of variable)
5.	Multicollinearity and diagnosis I
6.	Multicollinearity and diagnosis II
7.	Polynomial regression
8.	Nonlinear regression
9.	Generalized Linear Model
10.	Logistic regression
11.	Modes of convergence
12.	Application and verification of Weak Law of Large Number
13.	Application and verification of Central Limit Theorem
14.	Comparison of lengths of CI
15	MP test and UMP test