Swami Ramanand Teerth Marathwada University, Nanded
School of Mathematical Sciences

Two Year M. A. / M. Sc. Degree Program in Statistics

Revised Syllabi of M. A. / M. Sc. in Statistics

(Choice Based Credit System)

(To be implemented in the Department of Statistics, Swami Ramanand Teerth Marathwada University, Nanded)

(With effect from Academic Year 2014-2015)

1. Structure of the course: M.A./M.Sc. (Statistics)-Second Semester (CBCS Pattern)

SEMESTER-II								
Sr. No.	**Course**	**Course Title**	**Theory/ Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
STT 06	Core VI	Probability Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 07	Core VII	Regression Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 08	Core VIII	Parametric Inference	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 09	Core IX	Multivariate Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
STT 10	Core X	Stochastic Processes	**L/T**	**4**	**100**	**50**	**50**	**100**
STP 03	Core Practical III	Practical-III (based on STT 08 and STT 09)	**P**	**2**	**50**	**--**	**50**	**50**
STP 04	Core Practical IV	Practical-IV(based on STT 07 and STT 10)	**P**	**2**	**50**	**--**	**50**	**50**
		Total						**600**

List of Core/ Elective Subjects to be offered

Core Subjects

1. Probability Theory
2. Regression Analysis
3. Parametric Inference
4. Multivariate Analysis
5. Stochastic Processes
6. Practical-III (based on STT 08 and STT 09)
7. Practical-IV(based on STT 07 and STT 10)

NOTE:

1) Second semester will have five Theory papers and assessment for each theory paper will be of 100 Marks [50 External Exam+ 50 Internal Exam (02 tests each of 15 Marks+20 Marks for assignment].
2) One credit is of 25 marks.

STT 06 PROBABILITY THEORY

(Maximum no of periods: 60)

Unit I: Axiomatic definition of Probability, Probability measure on a s-field, Probability space (definition only), Properties of probability measure. Independence of two events and n>2 events, mutual independence,Sequence of independent events, Independent classes of events, Borel- Cantelli Lemma, Random Variable, Expectation of random variable, Linear properties of expectation. **(12L+3T)**

Unit II: Distribution functions and its properties, convergence of sequence of random variables, convergence almost sure, convergence in probability, convergence in distribution, convergence in r^{th} mean, inter relations between different types of convergences. Characteristic function, properties, inequalities, uniqueness theorem, Inversion theorem, continuity theorem. **(12L+3T)**

Unit III: Weak law of large numbers, Strong law of large numbers, Chebyshev's weak law of large numbers, Khinchin‟s weak law of large numbers, Kolmogorov's strong law of large numbers (statement only), Kolmogorov's inequality. **(12L+3T)**

Unit IV: Central Limit Theorem, Demoivre's, Laplace, Lindeberg -Levy, Lindeberg - Feller (sufficiency only) and applications. Multivariate central limit theorem. **(12L+3T)**

REFERENCES:

1) Bhat B. R. (2000) Modern Probability Theory, New age international.
2) Ash Robert (1972) Real analysis and probability, Academic press.
3) Mukhopadhy P. (2002) Theory of Probability, New central book agency, Calcutta.
4) Vardhan S. R. S. (2000) Probability Theory, New York University.
5) Billingsley P. P. (1986) probability and measure, Wiley.
6) Dudewicz E. J. and Mishra S. N. (1988) Modern Mathematical statistics, Wiley Int. student‟s Edition.
7) RohatgiV. K. (1984) An introduction to probability theory and Mathematical Statistics, Wiley Eastern.

STT 07 **REGRESSION ANALYSIS**

(Maximum no. of periods: 60)

UNIT I: 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 hypotheses about parallelism (Slopes) ,equality of intercepts, congruence, extrapolation, optimal choice of independent variables, , diagnostic checks and correction: graphical technique, tests for normality, uncorrelatedness, homoscadasticity, lack of fit, detection of outliers, Remedies. Weighted LS. **(12L+3T)**

UNIT II: Multiple regression: Standard Gauss-Markov setup, least square estimation, error and estimation spaces, variance and covariance of LS estimators, properties of LS estimators, testing of hypothesis for one and more than one linear parametric functions, confidence intervals Multicollinearity: Consequences, detection and remedies, autocorrelation consequences, Durbin Watson test, estimation of parameters in autocorrelation. **(12L+3T)**

UNIT III: Multiple correlations, partial correlation coefficient. Test for significance of simple, multiple and partial correlation coefficients, variable selection procedures. Residual and residual diagnostics, transformation of variables: Box- Cox power Transformation, generalized weighted least sequence. Mallows Cp Statistics, forward and backward selection method **(12L+3T)**

UNIT IV: Logistic regression: Logit transform, ML estimation, tests of hypothesis, Wald test, LR test, score test, test for overall regression Ridge regression, robust regression. Non-linear regression models, Least squares estimation in nonlinear regression, model building and diagnostics. **(12L+3T)**

REFERENCES:

1) Joshi D.D. (1987) Linear Estimation and design and analysis of experiments, Wiley Eastern.
2) Giri N (1986) Analysis of variance, South Asia Publishers.
3) Cook R.D. And Weisberg S. (1982) Residual and influence in Regression, Chapman and Hall.
4) Draper N.R.and Smity, H (1998) applied Regression analysis, 3rd ed. Wiley.
5) Rao. C.R. (2002) Linear Statistical Inference and its Applications, 2nd Ed. Wiley.
6) Weisberg S. (1985) Applied Linear Regression, Wiley.
7) Montegomery D.C., Peck, E.A. and Vining G.G.(2003). Introduction to Linear Regression Analysis,3rd Ed. Wiley.
8) Ratkowsky, D. A.(1983) Nonlinear regression modeling, Marcel Dekker.
9) Kutner, Neter, Nachtsheim and Wasserman (2003) Applied Linear Regression, 4th Ed., McGraw-Hill.

STT 08 **PARAMETRIC INFERENCE**
(Maximum no of periods: 60)

UNIT I: Introduction of Parametric models, Point estimation, Interval estimation, Joint distribution of a sample and sampling distribution of a Statistic. Likelihood function; examples from standard discrete and continuous models . **(12L+3T)**

UNIT II: Information in data about the parameters and variation in likelihood function, concept of no information. Sufficiency, Fisher's concept of sufficiency, Sufficient Statistic, Neyman Factorizability criterion, Likelihood equivalence, Minimal sufficient Statistic. **(12L+3T)**

UNIT III: Invariance property of sufficiency under one-one transformation of sample space. Exponential families and Pitman families. Fisher information for one and several parameters models.Maximum Likelihood methods, Methods of moments and percentiles. UMVUE, Rao-Blackwell theorem and its applications. Completeness property of family of distributions. Lehmann-Scheffe theorem, Necessary and sufficient condition for UMVUE. Cramer-Rao lower bound approach. **(12L+3T)**

UNIT IV: introduction to Bayesian estimation, prior & posterior distribution, loss function, principle of minimum expected posterior loss, quadratic & other common loss functions, conjugate family of prior distribution & its examples. **(12L+3T)**

REFERENCES:

1) Kale B.K. (1999) A First course on Parametric Inference, Narosa.
2) Casella G. & Beregar R.L.(2002) Statistical Inference, 2nd edition, Duxbury Advanced series.
3) Ferguson T.S (1996): A course on large sample Theory, Chapman and Hall.
4) Dudewitz E.J. & Mishra S.N.(1988) Modern mathematical Statistics, JohnWiley.
5) Lehman E.L. (1988) Theory of point estimation, John Wiley.
6) Lehman E.L. (1986) Testing of statistical hypotheses, John Wiley.
7) Rohatgi V.K and Saleh A.K. Md. E (2001) Introduction to Probability Theory and Mathematical Statistics, John –Wiley and Sons.
8) Rao C. R.(1973) Linear Statistical Inference & its Applications, 2nd Ed., Wiley.
9) George Casella, Roger L. Berger (2001) Statistical Inference,2nd Ed., Duxbury press.
10) Zacks S. (1971) Theory of Statistical Inference John Wiley and Sons, New York.

STT 09 **MULTIVARIATE ANALYSIS**
(Maximum no. of periods: 60)

UNIT I: Multivariate normal distribution, marginal and conditional distribution, singular and nonsingular normal distribution, Characteristic function, Maximum likelihood estimators of the mean vector and covariance matrix. **(12L+3T)**

UNIT II: Wishart Distribution: Wishart matrix- its distribution and properties, Distribution of sample generalized variance. Hotelling's T^2 statistics and its distribution. Application T^2 Statistics and its relationship with Mahalanobis D^2 Statistics. **(12L+3T)**

UNIT III: Principal components, Dimension reduction, Canonical variables and canonical correlation –definition, use, estimation and computation. Multivariate Analysis of Variance (MANOVA) of one and two–way classified data. **(12L+3T)**

UNIT IV: Classification and discrimination procedures for discrimination between two multivariate normal populations–sample discriminant function, probabilities of misclassification and their estimation. **(12L+3T)**

REFERENCES:

1) Anderson T.W. (1983) An Introduction to Multivariate Statistical Analysis, 2nd Ed. Wiley.
2) Giri N.C. (1977) Multivariate Statistical Inference, Academic press.
3) Kshirsagar A.M. (1972) Multivariate Analysis, Marcel Dekker.
4) Morrison D.F. (1976) Mathematical Statistics Methods, 2nd Ed Mc-Graw Hill.
5) Rao.C.R.(2002) Linear Statistical Inference and Its Application 2nd Ed. Wiley.
6) Seber G. A. F. (1984) Multivariate observations Wiley.
7) Sharma S. (1996) Applied multivariate techniques Wiley.
8) Srivastava S. and Khatri C.G. (1979) An introduction to Multivariate Statistics, North Holland.
9) Johnson and Wichern (1992) Applied multivariate Statistical Analysis, Prentice Hall 3rdEd.
10) Roy S.N.(1987) Some Aspects of Multivariate Analysis John Wiley.
11) Muirhead, R.J. (1982). Aspects of Multivariate Statistical Theory, J. Wiley.
12) Bhuyan K.C. (2005) Multivariate Analysis and its application, New Central book age., Ltd. Kolkatta.

STT 10 **STOCHASTIC PROCESSES**

(Maximum no. of periods = 60)

Unit I: Introduction to stochastic Processes (SP's) Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, calculation of n-step transition probability & its limit. Chapman-Kolmogorov equation, Stationary distribution, classification of states, criteria for various states, Ergodic theorem. **(12L+3T)**

Unit III: Random walk & gambler's ruin problem, absorbing and reflecting barriers, probability of eventual absorption, expected duration of game, random walk in 2 & 3 dimension. First passage time distribution. **(12L+3T)**

Unit IV: Discrete state space & continuous time Markov chain, Poisson process, properties of Poisson process, pure birth, pure death, Birth and death process. **(12L+3T)**

Unit V: Continuous state space, continuous time Markov chain, Wiener process, Wiener process as a limit of random walk, differential equation of Wiener process, first passage problem in Wiener process. Renewal and delayed renewal processes, related theorems, key renewal theorem (without proof) and its application. Galton-Watson Binaymi Branching process. Probability of ultimate extinction. Stationary Process: Weak Stationary and strong stationary processes. **(12L+3T)**

REFERENCES:

(1) Medhi, J. (1994) Stochastic Processes, Wiley Eastern.
(2) Bhat, B. R. (2000) Stochastic Models: Analysis and Applications, New Age International, India.
(3) Adke, S. R. and Manjunath, S. M. (1984) An Introduction to finite Markov Processes, Wiley Eastern.
(4) Parzen E. (1962) Stochastic Process, Holden-Pay.
(5) Karlin & Taylor, A. (1975) First Course in Stochastic Process, (Vol.1) Academic Press.
(6) Cinlar E.(1975) Introduction to Stochastic Process, Prentice Hall.
(7) Srinivas and Mehta (1976) Stochastic Processes, Tata McGraw Hill, New Delhi.
(8) Feller, W.(1968) Introduction to Probability and its Applications, (Vol.1) Wiley Eastern.
(9) Harris, T.E. (1963). The Theory of Branching Processes, (Springer-Verlag).
(10) Hoel, P.G., Port, S. C. and Stone, C. J. (1972) Introduction to Stochastic Processes, Houghton Miffin & Co.
(11) Jagers, P. (1974) Branching Processes with Biological Applications, Wiley.
(12) Ross, S. (2005) Introduction to Probability Models, 6th Ed. Academic Press.
(13) Taylor and Karlin (1984) An Introduction to Stochastic Modeling, Aca. Press