SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2018-19

(પીજી બોર્ડ તા. ૦૩/૦૫/૨૦૧૭)

MASTER OF SCIENCE (STATISTICS)

SEMESTER – III

CODE AND SUBJECT		Credit	Number of Hours of Teaching	Nature of the Course
PS03CSTA21	Deign of Experiments	4	4	C
PS03CSTA22	Multivariate Analysis	4	4	C
PS03ESTA21	Reliability and Life Testing	4	4	EL
	OR			
PS03ESTA22	Generalized Linear Models	4	4	EL
PS03ESTA23	Survival Analysis	4	4	EL
	OR			
PS03ESTA24	Time Series	4	4	EL
PS03CSTA23	Practicals	4	6	P
PS03CSTA24	Practicals.	4	6	P
PS03CSTA25	Comprehensive Viva-Voce	1	2	CVV

PS03CSTA21: DESIGN OF EXPERIMENTS

Unit 1	Introduction Experimental designs and principles. General block designs (GBD) and special cases BIBD and two associate PBIBD. Notion of cconnectedness, orthogonality, balancedness. Intra block analysis, Missing plot technique for GBD and its application to BIBD. Intra- block analysis and recovery of Inter- block information for BIBD.	**12L**
Unit 2	Youden square design and its analysis as BIBD with additional factor and as a row column design. Multi-factor Experiments. Concept of nested and crossed factors. Familiarity with crossed (factorial), Nested, Crossed-Nested Treatment designs. Analysis of variance and Analysis of covariance.	**12L**
Unit 3	Analysis of Two level factorial designs in single/ multiple replicates or randomized blocks. Confounding and fractional replication of factorial designs. Resolution III, IV, V designs. Application as first order response surface designs.	**12L**
Unit 4	Analysis of 3^2 designs: contrasts for linear and quadratic effects. Application as second order response surface designs. Concept of rotatable designs and Central composite designs (CCD). Box-Behnken design, Optimality of designs. Application to Response surface methodology (RSM): linear and quadratic model, stationary point.	**12L**

Books Recommended

1 K Hinkelmann Kempthorne (2005).. Design And Analysis Of Experiments, Vol 1, 2, Wiley

2 Petersen. R. G. (1985). Design & Analysis Of Experiment, Marcel Dekker

3 Cochran W G, Cox G M (1964). Experimental Designs. John Wiley and Sons

4 Daryl S. Paulson. (2003). Applied Statistical Designs For Researchers, Chapman and Hall

5 Nigam A K, Puri P D, Gupta V K. (1988). Characterisations Analysis Of Block Designs John Wiley and Sons

6 Aloke Dey. (2010). Incomplete Block Designs. World Scientific Publishing Co Pte Ltd

7 A Dean D Voss. (1999) Design & Analysis Of Experiment. Springer

8 G E.P.Box, N R. Draper (2007). Response Surfaces, Mixtures, Ridge Analyses. John Wiley and sons

9 Max Morris.(2011) Design Of Experimentss An Intro based On Linear Models. Chapman and Hall

10 D.G.Kabe, S.M.Shah. Design and Analysis of Expts (Queen's Uni)

11 D.D.Joshi. (1987). Linear Estimation And Design Of Experiments. New Age International

12 M.N.Das N.C.Giri. (2003) Design And Analysis Of Experiments. New Age International

13 Douglas C. Montgomery. (2012) Design And Analysis Of Experiments Eight ed. John Wiley

PS03CSTA22: MULTIVARIATE ANALYSIS

Unit 1 Multivariate normal distribution (characterization) and its properties. Random sampling from a multivariate normal distribution. Maximum likelihood estimation of parameters, Distribution of the MLEs. **12L**

Distribution of sample intra-class correlation coefficient in a random sample from a symmetric multivariate normal distribution. Application in testing and interval estimation.

Unit 2 Wishart matrix, its distribution and properties. Distribution of generalized variance. Wilk's lamda distribution. Null and non-null distribution of simple correlation matrix. Null distribution of partial and multiple correlation coefficients. Application in testing and interval estimation. **12L**

Unit 3 Distribution of Hotelling's T^2 statistic. Application in tests on mean vector for one and more multivariate normal populations and also on equality of the components of mean vector in a multivariate normal population. **12L**

Unit 4 Test concerning covariance matrices. Test for identical populations. **12L**

Multivariate linear regression model, estimation of parameters, tests of linear hypotheses about regression coefficients using LRT. Multivariate analysis of variance(MANOVA) of one and two way classified data.

Books Recommended

1 Srivastava, M. S. and Khatri, C. G. (1979). An Introduction to Multivariate Analysis, North-Holland, NY

2 **Anderson**,T.W. (2003). Introduction to Multivariate Statistical Analysis, Wiley, NY (3rd Edition) (student edition)

3 **Giri**, N C. (2004). Multivariate Statistical Inference (Second . Marcel Dekker,NY

4 **Kshirsagar,** A. M. (2006). Multivariate Analysis, Marcel Dekker, NY (2nd Edition)

5 **Johnson**, R.A. and Wichern, D.W.(1998). Applied Multivariate Statistical Analysis 4rd Ed.,PHI

6 *Mardia, K.V,Kent, J.T, and Bibby, J.M.(1979). Multivariate Analysis, Academic Press, NY*

7 **Muirhead**, R. J. (2005). Aspect of Multivariate Statistical Theory, Wiley, NY (reprint)

8 **Rao**,C.R.(2009).Linear Statistical Inference and its Applications, 2nd ed. Wiley,NY

9 **Saber**, G.A.F.(1984). Multivariate Observations, Wiley, NY

10 **Siotani**, M., Hayakawa, T., and Fujikoshi, Y.(1985). Modern Multivariate Statistical Analysis, American Sc. Prass, Inc.

11 Bhuyan, K. C. (2005). Multivariate Analysis and its Applications**,** New Central Book Agency (P) Ltd. India

PS03ESTA21: RELIABILITY AND LIFE TESTING

Unit 1	Reliability concepts, remaining life time, mean time between failure (MTBF), hazard function (HF), bath–shape HF, Reliability in terms of HF. Estimation of parameters and tests in these models. Reliability estimation based on failure times in various censored life tests and in tests with replacement of failed items.	**12 L**
Unit 2	Life distribution; reliability function; hazard rate; common life distributions-Exponential, Weibull, gamma, Pareto and lognormal distributions.	**12L**
Unit 3	Reliability concepts and measures; components and systems; coherent systems; reliability of coherent systems; cuts and paths; modular decomposition; bounds on system reliability; structural and reliability importance of components.	**12L**
Unit 4	Bayes estimator, for exponential, negative exponential, Weibull and normal life model. Estimation of survival function-Actuarial Estimator, Kaplan-Meier Estimator; Properties of K-M estimator;	**12L**

Books Recommended

1. Cox, D.R. and Oakes, D. (1984) Analysis of Survival Data, Chapman and Hall, New York.
2. Gross A.J. and Clark, V. A. (1975)Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
3. Elandt - Johnson, R.E. Johnson N.L. (1980) Survival models and Data Analysis, John Wiley and Sons
4. Miller, R.G.(1981) Survival Analysis (Wiley)
5. Barlow R. E. & Proschan F. (1975) Statistical Theory of Reliability & Life testing. Holt, Rinehart & Winston Inc.
6. Zacks, S. Reliability

PS03ESTA22: GENERALIZED LINEAR MODELS

Unit 1 Review of Linear Statistical Models, Discrete Response Data, Introduction of Generalized Linear Models (GLMs), Components: Linear Predictor, Link Function, Natural Parameters, Scale Parameters; Exponential Family of Distributions (EFD): Members of EFD: Normal, Lognormal, Exponential, Gamma, Binomial, Poisson, Negative Binomial; Steps for Model Fitting, Mean and Variance of EFD; Frequent Inference: Estimation of Parameters through Iteratively Reweighted Least Square (IRLS) and Algorithms, Form of Adjacent Dependent Variable and Weights, Analysis of Deviance, Nested Model and Non-Nested Model; Goodness of Fit Criteria: RSquare, Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Bayesian Information Criterion (BIC); Step Wise Selection; Testing of Parameters through Wald Test; Confidence Intervals; GLMs Residuals: Residual Analysis, Pearson Residual, Anscombe Residual, Deviance Residual. Model Checking: Hat Matrix, Outlier, Leverage, Influence **12 L**

Unit 2 Binary Data: Models for Binary Data: Group Data and Ungroup Data, Linear Predictor, Link Function: Logit, Probit and Complementary Log Log; Prospective Study and Retrospective Study, Likelihood Function, Estimation of Parameters through IRLS Method; Deviance; Probit Model, Residual Analysis **12L**

Polytomous Data: Introduction of Multinomial Logistic Regression and Ordinal Regression, Examples and their inference. Ordinal Regression Models with Qualitative or/and Quantitative Covariates; Parallel Line Regression

Unit 3 Count Data: Introduction Poisson Regression, Likelihood, Estimation and Testing of Parameters: Log Linear Model for Contingency Table and their Analysis **12L**

Generalized Linear Models with distribution having Constant Coefficient of Variation; Gamma Family; Canonical Link Function; Inference and Residual Analysis of GLMs with Gamma Distribution; Comparison between Response having Gamma distribution and lognormal distribution; Examples and Applications

Unit 4 Models for Survival Data: Estimation with Censored Survival Data and Survival Distribution: Exponential Distribution; Weibull Distribution and their Examples. **12L**

Under and Over Dispersion Problem of Data, Quasi Likelihood for Estimation of Parameters, Properties of Quasi Likelihood, Analysis of Deviance; Quasi Likelihood: Binomial, Poisson, Normal, Gamma, Lognormal, Exponential; Comparison of Quasi Likelihood with Likelihood; Concept of Marginal Likelihood, Conditional Likelihood;

Models with Nonlinear Parameters in Covariates; Model Checking: Checking Link Function, Checking Covariance Scale, Checking the Variance Function, Score Test for Extra Parameters, Checking Form of Covariates, Detection of Influential Observations

Books Recommended

1 Agresti, A. (2002). Categorical Data Analysis, ED.II, Wiley InterScience

2 Fahrmier,L .and Tutz,G.(2001). Multivariate Statistical Modeling Based on Generalizes Linear Models, Springer

3 Gill, J.(2001).Generalized Linear Models: A Unified Approach, Sage Publication

4 Lindsey, J.K. (1997). Applying Generalized Linear Models , Springer

5 Maindonald,J. And Braun,J. (2007). Data Analysis and Graphics using R: An example based approach Ed.II, Cambridge University Press

6 McCullagh, P. And Nelder,J.A. (1983). Generalized Linear Models- Monographs on Statistics and Applied Probability, Chapman and Hall

7 Myers, R.H, Montegomery, D.C., Vinning, G.G and Robinson, T.J.(2010). Generalized Linear Models with Applications in Engineering and the Sciences, Ed.II , Wiley Series in Probability and Statistics, A John Wiley & Sons.

PS03ESTA23: SURVIVAL ANALYSIS

Unit 1	Concepts of time, order and random censoring. Life distributions – exponential,l gamma, Lognormal, pareto, linear failure rate. Parametric inference, point estimation, confidence Intervals, scores, tests based on LR, MLE.	**12L**
Unit 2	Life tables, failure rate, mean residual life and their elementary properties. Ageing classes - IFR, IFRA, NBU, NBUE, HNBUE and their duals, Bathtub failure rate. Estimation of survival function - Actuarial estimator, Kaplan - Meier estimator. Estimation under the assumption of IFR/DFR	**12L**
Unit 3	Semi-parametric regression for failure rate - Cox's proportional hazards model. Competing risk models. Repair models. Probabilistic models. Joint distribution of failure times. Unconditional tests for the time truncated case. Tests for exponentiality, two sample non-parametric problem.	**12L**
Unit 4	Concept of frailty. Shared frailty models. Identifiability of frailty models. Various frailty models. Gamma, positive stable, inverse Gaussian, power variance function, compound Poisson and compound negative binomial shared frailty models. Frailty regression models. Bivariate and correlated frailty models. Additive frailty models. Reversed hazard rates, Cox's proportional reversed hazards model	**12L**

Books Recommended

1 Cox, D.R. and Oakes, D. (1984). Analysis of Survival Data, Chapman and Hall.

2 Deshpande, J.V. and Purohit S.G. (2005). Life Time Data: Statistical Models and Methods, Word Scientific.

3 Duchateau, L. and Johnson, P. (2008). The Frailty Model. Springer: New York

4 Gross A.J. and Clark, V. A. (1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons

5 Hanagal, D. D. (2011). Modeling Survival Data Using Frailty Models. CRC Press: New York.

6 Hougaard, P. (2000). Analysis of Multivariate Survival Data. Springer: New York

7 Wienke, A. (2011). Frailty Models in Survival Analysis, CRC Press: New York

PS03ESTA24: TIME SERIES

Unit 1	Exploratory time series analysis, tests for trend and seasonality. Exponential and Moving average smoothing. Holt -Winters smoothing. Forecasting based on smoothing, adaptive smoothing. Time - series as a discrete parameter stochastic process. Auto covariance and autocorrelation functions and their properties, Portmanteau tests for noise sequences, transformation to obtain Gaussian series.	**12L**
Unit 2	Stationary processes: General linear processes, moving average (MA), auto regressive (AR), and autoregressive moving average (ARMA). Stationarity and 33 inevitability conditions. Nonstationary and seasonal time series models: Auto regressive integrated moving average (ARIMA) models, Seasonal ARIMA (SARIMA) models, Transfer function models (Time series regression).	**12L**
Unit 3	Forecasting in time series models, Durbin-Levinson algorithm, innovation algorithm (without proof). Estimation of mean, auto covariance and autocorrelation functions, Yule-Walker estimation, Estimation of ARIMA model parameters, maximum likelihood method, large sample theory (without proofs). Choice of AR and MA periods, FPE, AIC, BIC, residual analysis and diagnostic checking. Unit-root non stationarity, unit-root tests	**12L**
Unit 4	Multivariate Time series model, VAR models, Vector ARMA models. Conditional heteroschedastic models, ARCH and GARCH, properties, examples, estimation & forecasting, extensions of ARCH & GARCH	**12L**

Books Recommended

1. Brockwell, P.J. and Davis, R. A. (2003). Introduction to Time Series Analysis, Springer
2. Chatfield, C. (2001). Time Series Forecasting, Chapmann & hall, London
3. Fuller, W. A. (1996). Introduction to Statistical Time Series, 2nd Ed. Wiley
4. Hamilton N. Y. (1994). Time Series Analysis. Princeton University press
5. Kendall, M. and Ord, J. K. (1990). Time Series, 3rd Edn. Edward Arnold
6. Lutkepohl, H. and Kratzing, M. (Ed.) (2004). Applied Time Series Econometrics, Cambridge University Press.
7. Shumway, R. H.and Stoffer D. S. (2010). Time Series Analysis & Its Applications, Springer. 8. Tsay, R. S. (2010). Analysis of Financial Time Series, Wiley.