SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

SYLLABUS FOR PRE-Ph.D. ENTRANCE TEST

SUBJECT: STATISTICS

Section B

Unit I Probability: Sample space, discrete probability, Simple theorems on probability, Independence of events, Bayes Theorem, Discrete and continuous random variables, Axiomatic definition of probability. Random variables and distribution functions (univariate and multivariate); expectation and moments; independent events and independent random variables; Bayes theorem; marginal and conditional distribution in the multivariate case, covariance matrix and correlation coefficients. Moment generating functions, characteristic functions; probability inequalities (TChebyshev, Markov, Jensen). Convergence in probability and in distribution; weak law of large numbers and central limit theorem for independent identically distributed random variables with finite variance.

Unit II Probability Distribution: Bernoulli, Binomial, Multinomial. Hyper-geometric, Poisson, Geometric and Negative binomial distributions, Uniform, exponential, Cauchy, Beta, Gamma, and normal distributions. Transformations of random variables, sampling distributions: t, F and chi-square distributions as sampling distributions, as sampling distributions, Standard errors and large sample distributions. Distribution of order statistics and range.

Unit III Sample Surveys: Simple random sampling with and without replacement. Stratified sampling; allocation problem; systematic sampling two stage sampling. Related estimation problems in the above cases. Sampling with varying probability of selection, Hurwitz-Thompson estimator; PPS sampling: Double sampling. Cluster sampling. Non-sampling errors. Multiphase sampling. Ratio and regression methods of estimation.

Unit IV Design of Experiments: Analysis of variance: one-way and two-way classification (equal number of observations per cell). Basic principles of experimental design. Randomization structure and analysis of completely randomized, randomized blocks and Latin-square designs. Factorial experiments. Analysis of 2^n factorial experiments in randomized blocks.

Unit V Linear Programming: Convex sets, Linear Programming Problem (LPP).Examples of LPP. Hyperplane, open and closed Half-spaces. Feasible, basic feasible and optimal solutions. Extreme point and graphical method. Simplex method, artificial variable techniques, Duality in

linear programming. Transformation and assignment problems. Two person-zero sum games. Equivalence of rectangular game and linear programming.

Unit VI Statistical Methods and Data Analysis: Graphical representation, measures of central tendency and dispersion. Bivariate data correlation and regression. Least squares-polynomial regression, Tests for mean and variance in the normal distribution: one-population and two-population cases; related confidence intervals. Tests for product moment, partial and multiple correlation coefficients; comparison of k linear regressions. Fitting polynomial regression; related test Analysis of discrete date: chi-square test of goodness of fit, contingency tables.

Unit VII Nonparametric tests: Sign test, Median test, Mann-Whitney test, Wilcoxon test for one and two-samples, Rank correlation and test of independence.

Unit VIII Theory of Estimation: Methods of estimation. Unbiasedness, efficiency, consistency. Cramer-Rao inequality. Sufficient, Statistics. Rao-Blackwell theorem. Uniformly minimum variance unbiased estimators. Estimation by confidence intervals. Simple and composite hypotheses, two types of errors, critical region, randomized test, power function, most powerful and uniformly most powerful tests. Likelihood-ratio tests. Wald's sequential probability ratio test.

Unit IX Time Series: Meaning of time series, components of time series, Trend, seasonal variation, cyclical variation, irregular component, Models of time series, Analysis of time series , Applications of time series, Autoregressive model AR (I). Graphical method, Method of Exponential Smoothing, Method of moving averages, Method of least squares, Measurement of Seasonal fluctuations by Method of simple averages, Ratio to trend method, Ratio to moving average method.

Unit X Index Number: Introduction, problems involved in the construction of Index Numbers, calculation of price and Quantity Index numbers, simple(Un weighted)Aggregate method, Weighted Aggregates method, Laspeyre's price Index, Paasche's price Index, Drobish-Bowley price. Index numbers, Marshlleara-Edgeworth price Index, Irving Fisher's Ideal Index number. Quantity Index numbers, Value Index numbers, Average of Price relatives. Weighted average relatives .Chain Indices, Procedure of construction of chain indices. The criteria of a good Index Numbers, Unit Test, Time Reversal Test, Factor reversal test, Circular Test, Uses and Limitations of Index Number.

Unit I Probability Theory and Probability Distribution: Sequences of events and random variables: Zero-one laws of Borel and Kolmogorov. Almost sure convergence, convergence in mean square, Khintchine's weak law of large numbers; Kolmogorov's inequality, strong law of large numbers. Convergence of series of random variables, three-series criterion. Central limit theorems of Liapounov and Lindeberg-Feller. Conditional expectation, martingales.

Properties of distribution functions and characteristic functions; continuity theorem, inversion formula, Representation of distribution function as a mixture of discrete and continuous distribution functions; Convolutions, marginal and conditional distributions of bivariate discrete and continuous distributions. Relations between characteristic functions and moments; Moment inequalities of Holder and Minkowski.

Unit II Statistical Inference and Decision Theory: Statistical decision problem- non-randomized, mixed and randomized decision rules; risk function admissibility, Bayes rules, minimax rules, least favourable distributions, complete class and minimal complete class. Decision problem for finite parameter space. Convex loss function. Role of sufficiency. Admissible, Bayes and minimax estimators; illustrations. Unbiasedness. UMVU estimators. Families of distributions with monotone likelihood property, exponential family of distributions. Test of a simple hypothesis against a simple alternative from decision-theoretic viewpoint. Tests with Neyman structure. Uniformly most powerful unbiased tests. Locally most powerful tests. Inference on location and scale parameters; estimation and tests. Equivariant estimators. Invariance in hypothesis testing.

Unit III Large sample statistical methods: Various modes of convergence. CLT, Scheffe's theorem, Polya's theorem and Slutsky's theorem. Transformation and variance stabilizing formula. Asymptotic distribution of function of sample moments. Order statistics and their functions. Tests on correlations, coefficient of variation, skewness and kurtosis. Pearson Chi-square, contingency Chi-square and likelihood ratio statistics. U-statistics consistency of Tests. Asymptotic relative efficiency.

Unit IV Multivariate Statistical Analysis: Singular and non-singular multivariate distributions. Characteristics functions. Multivariate normal distributions, marginal and conditional distributions; distribution of linear forms, and quadratic forms, Cochran's theorem. Inference on

parameters of multivariate normal distributions. Wishart distribution. Hotellings T^2, Mahalanobis D^2 Discrimination analysis, Principal components, Canonical correlations, Cluster analysis.

Unit V Linear Models and Regression: Standard Gauss-Markov models; Estimability of parameters; best linear unbiased estimates; Method of least squares and Gauss-Markov theorem; Variance-covariance matrix of BLUES. Tests of linear hypothesis; One-way and two-way classifications. Fixed, random and mixed effects models; variance components, Bivariate and multiple linear regressions; Polynomial regression; use of orthogonal polynomials. Analysis of covariance. Linear and nonlinear regression outliers.

Unit VI Design of Experiments: Factorial experiments, confounding and fractional replication. Split and strip plot designs; Quasi-Latin square designs; Youden square. Design for study of response surfaces; first and second order designs. Incomplete block designs; Balanced, connectedness and orthogonality, BIBD with recovery of inter-block information PBIBD with 2 associate classes. Analysis of series of experiments, estimation of residual effects. Construction of orthogonal-Latin squares, BIB designs, and confounded factorial designs. Optimality criteria for experimental designs.

Unit VII Time Series Analysis: Discrete-parameter stochastic processes; strong and weak stationarity; autocovariance and autocorrelation. Moving average, autoregressive, autoregressive moving average and autoregressive integrated moving average processes. Box Jenkins models. Estimation of the parameters in ARIMA models; forecasting. Periodogram and correlogram analysis.

Unit VIII Stochastic Processes: Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution; branching processes; Random walk; Gambler's ruin. Markov processes in continuous time; Poisson processes, birth and death processes, Wiener process.

Unit IX Operations Research:

General linear programming problems. Theory of Simplex methods: Introduction, slack and surplus variables, some definitions and notations, Fundamental theorems of linear programming, BSF from F.S., Improved B.S.F. Unbounded solution, optimality of solutions. Computational procedure of simplex method for the solution of a maximization L.P.P., artificial variable technique, Revised simplex method, dual simplex method, duality and sensitivity analysis. Introduction, competitive game, finite and infinite game, two person zero sum game, rectangular

game, solution of game, saddle point, solution of a rectangular game with saddle point. PERT-CPM, product planning control with PERT-CPM.

Unit X Industrial Statistics, Demography and Vital Statistics: Control charts for variables and attributes; Acceptance sampling by attributes, OC and ASN functions, AOQL and ATI; Tolerance limits Reliability analysis: Hazard function, distribution with DFR and IFR; Series and parallel systems. Life testing experiments. Measures of fertility and mortality, period and Cohort measures. Life tables and its applications; Methods of construction of abridged life tables. Application of stable population theory to estimate vital rates. Population projections. Stochastic models of fertility and reproduction.