Annexure C

FIRST SEMESTER

DETAILED SYLLABUS

Course No. PSSSTC 101 **Title: Real Analysis**

Credits: 4

Syllabus for the examinations to be held in December 2014, 2015 and 2016.

OBJECTIVES: This course introduces the students to concepts of Real Analysis.

Unit I

Introduction to Real number system, introduction to n-dimensional Euclidean space: Limit Points of a set, open sets, closed sets etc. (will be developed through general metric space and R^n will be considered as a special case, Compact sets, Bolzano-Weirsstrass theorem, Heine-Borel Theorem.

Unit II

Sequences and Series of real numbers, limit superior, limit inferior and limit of a sequence, their convergence, Cauchy sequence, Convergence of series, tests for convergence for series, absolute convergence, Cauchy products.

Unit III

Uniform convergence of sequences and series, Stone-Weirstrass theorem, power series, Fourier Series, Mean Value Theorem, Inverse function theorem, Implicit function theorem.

Unit IV

Improper integrals of first and second kind for one variable. Uniform convergence of improper integrals, differentiation under the sign of integral, Leibnitz rule, multiple integrals and their evaluation by repeated integration.

Books Recommended

1. Apostol, T.M. (1985): Mathematical Analysis, Narosa, Indian Edition.
2. Courant, R- and John F, (1965): Introduction to calculus and Analysis Wiley.
3. Miller, K.S (1957): Advanced Real calculus, Harper, New York.
4. Rudin, Walter (1976): Principles of Mathematical Analysis, McGraw.
5. Bartle, R.G (1976): Elements of Real Analysis (Wiley)

Course No. PSSSTC 102 **Title : Linear Algebra**

Credits: 4

OBJECTIVES: This course introduces the students to concepts of Linear Algebra.

Syllabus for the examinations to be held in December 2014, 2015 and 2016.

Unit I

Algebra of matrices, elementary matrices, linear transformations, row and column spaces of a matrix, rank and inverse of a matrix, null space and nullity, partitioned matrices, Kronecker product, fields, vector spaces, sub spaces, linear dependence and independence, basis and dimension of a vector space, finite, dimensional vector spaces, completion theorem, examples of vector spaces over real and complex fields.

Unit II

Vector spaces with an inner product, Gram-Schmidt Orthognalization process, Hermite canonical form, generalized inverse, Moore Penrose generalized inverse, left weak and right weak g-inverses, Idempotent matrices, solution of matrix equations. Gauss elimination method, triangulation method, Jacobin method and Gauss- Siedul iterative method.

Unit III

Real quadratic forms, reduction and classification of quadratic forms, index and signature, triangular reduction of a positive definite matrix, characteristic roots and vectors, Cayley-Hamilton theorem, similar matrices, Hermitian quadratic forms.

Unit IV

Algebraic and geometric multiplicity of a characteristic root, spectral decomposition of a real symmetric matrices, reduction of a pair of real symmetric matrices, singular values and singular value decomposition, vector and matrix differentiation.

Books Recommended:

1. Graybill, F.A (1983): Matrices with applications in Statistics, 2nd Edition Wadsworth.
2. Rao, C. R. (1973): Linear Statistical Inference and its Applications, 2nd Edition John wiley and Sons, Inc.
3. Searle, S.R. (1982): Matrix Algebra Useful for Statistics, John Wiley and Sons Inc.

Add References

1. Bellman, R. (170): Introduction to matrix Analysis 2nd Edition. Mc Graw Hill.
2. Biswas, S. (1984): Topics in Algebra of matrices Academic publications.
3. Hadley, G. (1987): Linear Algebra, Narosa Publishing House.
4. Halmos, P.R.(1958): Finite Dimensional Vector Spaces 2nd Edition D. Van Nostrand Company, Inc.

Course No. PSSSTC103 **Title: Distribution Theory**

Syllabus for the examinations to be held in December 2014, 2015 and 2016.

OBJECTIVES : The objectives of this course is to make the students familiar with Distribution Theory.

Unit-I

Review of random variable and basic distribution theory. Joint, marginal and conditional p.m.fs. and p.d.fs. Functions of random variable and their distribution using Jacobean transformation and other tools, Standard discrete distributions viz., Binomial, Poisson, Rectangular, Negative binomial, Hyper Geometric.

Unit II

Standard continuous distributions viz., Normal, Uniform, Cauchy, Beta, Gamma, Log normal, Exponential, Bivariate normal, Bivariate Exponential (Laplace); Order statistics and their distribution, Joint and marginal distributions of order statistics, Distribution of median and range

Unit III

Introduction to special distributions: Degenerate, Two-point, negative Hypergeometric, Multinomial, Pareto, Logistic, Weibul and Rayleigh distributions. Conditional expectations, Simple, partial and multiple correlations, linear and multiple regression.

Unit IV

Compound, truncated and mixture distributions, Sampling distributions, Central and Non-central Chi-square, t-and F- distributions and their properties, Chebyshevs, Markov, Holder, Jensen and Lyapunov inequalities.

Books Recommended:

1. Fisz: Theory and Mathematical Statistics.
2. Rohtagi, V.K & Ehsanes Saleh,A.K.: Statistics. Wiley — An Introduction to Probability Theory and Mathematical Series.
3. Kendall, M.G., Stuart, A: The Advanced Theory of Statistics: Distribution Theory. Vol. 1
4. Johnson and Kotz: Continous Univariate Distributons, vol 1 and vol. 2 Wiley.
5. Rohtagi, V.K.: An Introduction to Probability Theory and Mathematical Statistics.

Course No. PSSSTC 104 **Title: Sample Surveys**

Syllabus for the examinations to be held in December 2014, 2015 and 2016.

OBJECTIVES : The objectives of this course is to make the students familiar with various sampling methods.

Unit I

Estimation of sample size, Stratified random sampling, different methods of allocation, relative precision of stratified random sampling with S.R.S., formation and construction of strata, Post Stratification and Deep Stratification.

Unit-II

Systematic sampling, estimation of mean and sampling variance, comparison of systematic sampling with stratified and S.R.S., interpenetrating systematic sampling, Varying probability sampling methods of selecting sample with p.p.s, p.p.s, sampling W.R., efficiency of p.p.s. sampling. PPS WOR, H.T. estimator, Des Raj Sampling strategy, Murthy estimator, Sen-Midzuno method.

Unit-III

Ratio estimator, bias and mean square error, estimation of variance, comparison with SRS, ratio estimator in stratified sampling, unbiased type ratio estimators Difference estimator, regression estimator, comparison of regression estimator with SRS and ratio estimator, Cluster sampling with equal and unequal cluster sizes, relative efficiency with SRS and optimum cluster size.

Unit-IV

Two stage sampling with equal and unequal s.s.u's, estimation of mean and sampling variance. Successive sampling, sampling on two occasions. Randomized response Technique.

Books Recommended:

1. W.G. Cochran : Sampling techniques.
2. M.N. Murthy : Sampling Theory and Methods.
3. Des Raj : Sampling Theory.
4. P. Mukhopadhayay : Theory and methods of survey sampling.
5. D.Singh and F.S Chaudhary Theory and Analysis of sample Survey Designs.

Course No. PSSSPC 105 **Title: Software Lab-I**

Objectives: To make students familiar with the compilation and Statistical analysis of data using Statistical Software

Syllabus: Based on the Descriptive and inductive statistics

Course No. PSSSPC 106 **Title: Practical (Linear Algebra)**

Objectives: To make students familiar with the computation work based on Course No. PSSSTC 102.

Syllabus: Based on the Course PSSSTC 102 covering the following:

Topic	No. of Practicals
Algebra of matrixes and vector space	7
G-inverse, matrix equations and Gram-Schmidt Processes	10
Quadratic forms and characteristic roots and vectors	7
Total	**24**

Annexure D

SECOND SEMESTER

Course No. PSSSTC 201 **Title : Probability Theory**

Syllabus for the examinations to be held in May 2015, 2016 and 2017.

OBJECTIVES: This course introduces the students to concepts of Probability and Measure Theory.

Unit I

Fields, sigma minimal sigma field, sigma-field generated by a class of subsets, Borel fields. Sequence of sets, limsup and liminf of sequence of sets, Measure, probability measure, properties of a measure, Continuity theorem of measure, Caratheodory extension theorem (statement only), Idea of Lebesgue and Lebesgue-Steiltjes measure, Signed measure, Jordan-Hahn decomposition theorem.

Unit II

Measurable functions, integration of a measurable function with respect to a measure, Monotone convergence theorem, Fatou's lemma, dominated convergence theorem, Radon Nikodym Theorem, Product measure, Fubini's Theorem, Borel Cantelli Lemma, Zero-One Laws of Borel and Kolmogrov.

Unit III

Convergence of a sequence of r.v.s, Almost sure convergence, convergence in probability, convergence in distribution, weak law and strong law of large numbers of sequences, Convergence of series of random variables, Three series criterion, Martingales.

Unit IV

Characteristic functions, and their simple properties, Parseval relation, Uniqueness theorem, Inversion theorem, Levy's continuity theorem (statement only), CLT for lid random variables. CLT for a sequence of independent random variables under Lindeberg's condition, statements of Liapounov and Lindberg-Feller theorems.

Books Recommended

1. Ash, Robert (1972) Red Analysis and Probability, Academic Press.
2. Billinsley P. (1986) Probability and measure, Wiley.
3. Dubey, R.M. (1086) Real Analysis and Probability, Wadsworth and Brooks/cole.
4. Kingman JFC and Taylor SJ (1966) Introduction to measure and probability. Cambridge University press.
5. B R Bhat (1985) Modern Probability Theory
6. Basu, A.K. (2001) Probability and Measure theory, Narosa Pub.

7. Laha, R.G and Rohtagi, V K (1997) Probability theory, John Wiley
8. Rohtagi, V K and Saleh A K (2005) Probability Theory, John Wiley
9. Chung, K L (2001) A Course in Probability Theory, Academic Press
10 Feller, W. (1969) Introduction to Probability and its Application Vol. II (Wiley Eastern Ltd.)
11. Loeve, M. (1978). Probability theory (4^{th} edn) (Springer Verlag)
12. Gnedenko, B.V(1988) Probability Theory (Mir. Pub.)

Course No. PSSSTC 202 **Title : Design and Analysis of Experiments**

Syllabus for the examinations to be held in May 2015, 2016, and 2017

OBJECTIVES : The aim of this course is to provide the knowledge of Design and Analysis of Experiments.

Unit I

Introduction to Design Experiments: General Block Design and its information matrix (c), Criteria for connectedness, balance and orthogonolity, intrablock analysis (estimability), best point estimates/interval estimates of estimable linear parametric functions and testing of linear hypothesis). Fixed mixed and random effects models, variance components estimation, study of various methods.

Unit II

Missing plot techniques in RBD and LSD, Symmetrical Factorial experiments with factors at two and three levels (2^n, 3^2, 3^3), Confounding-Total and Partial in factorial experiments, Split plot Design.

Unit III

Incomplete and Balanced incomplete block designs, Lattice and Youden squares, partially balanced incomplete block design and its analysis.

Unit IV

Analysis of Covariance in RBD, LSD and CRD, Analysis of Covariance in Non-orthogonal Data in two way classification, Covariance and Analysis of experiments with missing observation.

BOOKS RECOMMENDED:

1. D.D. Joshi : Linear Estimation and Design of Experiments.
2. O. Kempthorne Design and Analysis of Experiments.
3. Das and Giri Design and Analysis of Experiment.
4. Cochran and Cox Design of Experiments.
5. Aloke Dey (1986): Theory of Block Designs, Wiley Eastern.
6. Giri, M.N and Giri N (1979) Design and Analysis of Experiments, Wiley Eastern.
7. Montogomery C.D (1976) Design and Analysis of Experiments, Wiley, New York
8. Rao, C.R. and Kleffe J. (1988) Estimation of Variance Components and applications,
9. Searle, S.R. Casella G. and McCulloch, C.E (1992) Variance Components, Wiley.

Course No. PSSC 203 **Title : Inference-I**

Syllabus for the examinations to be held in May 2015, 2016 and 2017

OBJECTIVES : The aim of this course is to provide the knowledge of Inference to the students.

Unit I

Introduction to estimation; unbiasedness, consistency, sufficiency and Minimal sufficiency, CAN estimators, Mean Square Error, Completeness and Bounded completeness, Factorization Criterion, Finite and asymptotic efficiency.

Unit II

UMVUE, Cramer-Rao inequality, Chapman-Robbins-Keifer lower bound, Rao-Blackwell Theorem, Lehmann Scheffe Theorem, Exponential and Pitman families

Methods of Estimation: Maximum Likelihood method, methods of moments and percentiles.

Unit III

Testing of hypothesis; Basic concepts, randomized and nonrandomized test procedures, Neyman-Pearson Lemma, Families with MLR property, Examples of UMP unbiased tests for two sided hypothesis (Only for exponential families), Wald's SPRT, Likelihood ratio test and its properties (without proof) and applications to normal distribution.

Unit IV

U- Statistics, its definition, properties as an estimator of its expectation, One-Sample and 2-Sample non parametric tests for Location (only standard test), Non parametric confidence intervals for percentiles, Interval estimation, confidence level, construction of confidence, intervals using pivots, shortest expected length confidence interval.

Books Recommended

1. Kale, B.K (1999): A first course a Parametric Inference, Narosa Publishing House.
2. Rohtagi, V.K. (1988): An introduction to probability and Mathematics Statistics, Wiley Eastern Ltd. New Delhi (Student Edition)
3. Fergusan T.S. (1967) Mathematical Statistics, Academic Press.
4. Zacks, S. (1971): Theory of Statistical Inference, John Wiley and sons, New York.
5. Lehman, E.L. (1988)- Theory of Point Estimation.
6. Lehman , E.L. (1988)- Testing Statistical Hypothesis.
7. Rao, C.R. (1973): Linear Statistical Inference.

Course No. PSSSTC 204 **Title : Multivariate Analysis**

Syllabus for the examinations to be held in May 2015, 2016 and 2017

OBJECTIVES : The aim of this course is to provide the knowledge of Multivariate Analysis to the students.

Unit I

Multivariate normal distribution, Maximum likelihood estimates of mean vector and dispersion matrix, Distribution of sample mean vector, Wishart matrix-its distribution and properties, Null distribution of simple, partial and multiple correlation coefficients and their testing of significance.

Unit II

Hotelling's T^2 statistic-its distribution and application in testing of mean vector for one and more multivariate normal populations, Mahalonobis D2 staistics and its application. Problem of classification, probabilities of misclassification and their estimation, classification into more than two multivariate normal populations, Discrimination procedures for discriminating between two multivariate populations-sample discriminant function.

Unit III

Multivariate linear regression model-estimation of parameters, Distribution of sample regression coefficients, tests of linear hypothesis about regression coefficients, Multivariate Analysis of Variance (MANOVA) of one and two way classified data.

Unit IV

Principal Components Analysis, Factor Analysis Canonical variates and canonical correlations.

Books Recommended

1. Anderson, T.W: An introduction to Multivariate Statistical Analysis.
2. Morrison, D.F.: Multivariate Analysis.
3. Johnson, R. and Wychern: Applied Multivariate Statistical Analysis.
4. Jobson, D.B.: Applied Multivariate Analysis.

Course No. PSSSPC 205 **Title: Practical (Design of Experiments)**

Objective: To make students familiar with the computation work based on Course No. PSSSTC 202

Course No. PSSSPC 206 **Title: Practical (Multivariate Analysis)**

Objective: To make students familiar with the computation work based on Course No. PSSSTC 204

Further, each student will have to submit a small project on application of any multivariate Analysis using statistical software.

Annexure I

Semester III

Syllabus for the examinations to be held in December 2015, 2016 and 2017

PSSSTC 301: Linear Models & Regression Analysis **4 Credits**

OBJECTIVES: The aim of this course to provide the knowledge of Linear Models and Regression analysis.

Unit I

Gauss-Markov set-up, Normal equations and Least squares estimates, Error and estimation spaces, variances and covariances of least squares estimates, estimation of error variance, estimation with correlated observations, least squares estimates with restriction on parameters.

Unit II

Simultaneous Estimates of linear Parametric functions, Tests of hypothesis for one and more than one linear parametric functions, confidence intervals and regions, Analysis of Variance, Power of F-test, Multiple comparison tests due to Tukey and Scheffe, simultaneous confidence intervals.

Unit III

Introduction to One-way random effects linear models and estimation of variance components, Simple linear Regression, multiple and polynomial regression, orthogonal polynomials.

Unit IV

Residuals and their plots as tests for departure from assumptions such as fitness of the model, normality, homogeneity of variances and detection of outliers, Remedies, Introduction to non-linear models; least squares in non-linear case, estimating the parameters of a non linear system, reparameterization of the model, the geometry of linear and non linear least squares.

Books Recommended:

Cook, R.D. and Weisber, S. (1982), Residual and Influence in Regression, Chapman and Hall.

Draper, N.R. and Smith, H. (1988), Applied Regression Analysis 3rd Ed. Wiley.

Gunst, R.F. and Mason, R.L. (1980). Regression Analysis and its Application-A Data Oriented Approach, Marcel and Dekker.

Rao, C.R. (1973), Linear Statistical Inference and Its

Weisber S. (1985) Applied Linear Regression, Wiley Eastern.

Wiley. D.C. Montegomery and EA Peck (1982). Introduction to Linear Regression Analysis, John Wiley and sons.

F.A Graybill (1976) Theory and Application of the Linear Models.

Applications, Wiley.