

SRI VENKATESWARA UNIVERSITY :: TIRUPATI
SVU COLLEGE OF SCIENCES
Department of Statistics

Re-Structured P.G. Programme (CBCS) as per NEP 2020, National Higher Education
Qualification Frame Work (NHEQF) and Guidelines of APSCHE

(With effect from the batch of Students admitted from the academic year 2024-25)

MASTER OF SCIENCES (Applied Statistics)

SEMESTER - I								
S. No	Course	Code	Title of the Course	H/W	C	SEE	IA	Total Marks
1	CC	101	Probability and Distributions	4	4	70	30	100
2		102	A. Measure Theory and Linear Algebra	4	3	50	25	75
			B. Financial Statistics					
3		103	A. Advanced Survey Sampling Theory	4	3	50	25	75
			B. Statistical Methodology					
4		104	Practical-I (APST 102 & APST 103)	6	2	35	15	50
5	SOC	105	A. Statistical Analysis using SPSS and Excel	4	3	50	25	75
			B. Statistical Computing and Data Analysis					
6		106	A. Applied Stochastic Process and Review Theory	4	3	50	25	75
			B. STATISTICAL COMPUTING					
7	*P	107	Practical-II(APST 105 & APST 106)	6	2	35	15	50
			Total	36	20	340	160	500
8	Audit Course	109	Research Methodology	4	0	0	100	0

- CC (Core Courses) - 1st Core Course is mandatory and 2nd & 3rd Core Courses Student can choose one from each code
 - *SOC (Skill Oriented Courses) – Student can choose one from each code
 - *Practical – I relating to 2nd & 3rd Core Courses and Practical - II relating to 1st & 2nd Skill Oriented Courses (SOC)
- Audit Course – Zero Credits but mandatory with only a Pass

APST 101: PROBABILITY AND DISTRIBUTIONS

Unit-I: Classes of sets, fields, σ -fields, minimal σ -field, Borel σ – field in R^K , sequence of sets, limsup and liminf of a sequence of sets. Measure, Probability measure, properties of a measure, Lebesgue and Lebesgue-Stieltjes measures, Measurable functions, Random variables, sequence of random variables, almost sure convergence, convergence in probability (and in measure). Monotone convergence theorem, Fatou’s lemma, Dominated convergence theorem.

Unit-II: Expectation of a random variable, inequalities on expectations, Markov, Holder, Jensen and Liapiunov inequalities. Borel- Cantelli - Lemma, Independence, Weak law and strong law of large numbers for iid sequences, Chebyshev’s theorem, khinchine’s theorem, Kolmogorov theorems (statements only), convergence in distribution.

Unit-III:Laplace and Weibull distributions.Functions of random variables and their distributions, sampling distributions: central Chi Square, t and F distributions and its properties, applications, relation between t and F, F and χ^2 ; Fisher’s Z-distribution, fisher’s Z-transformation. Non-central chi-square, t and F distributions and their properties.

Unit-IV: Multiple and partial correlation coefficients, multiple linear regression, inter relationship among partial and multiple correlation and regression coefficients. Null distributions of simple, partial and multiple correlation coefficients. Order statistics and their distributions, joint and marginal distributions of order statistics, distribution of range. Extreme values and their asymptotic distributions.

References

1.

Ash, Robert. (1972). Real Analysis and Probability. Academic Press.

2.

Billingsley, P. (P. (1986) Probability and Measure. Wiley.

3.

Kingman, J F C and Taylor, S. J. (1966). Introduction to Measure and Probability. Cambridge University Press.

4.

Loeve, M (1963), Probability theory

5.

Bhatt B.R (1998), Modern Probability theory, Wiley Eastern

6.

Rohatgi V.K. (1984): An Introduction to probability theory and mathematical Statistics.

7.

Rao C.R (1973): Linear Statistical Inference and its Applications, 2/e, Wiley Eastern.

8.

Pitman J. (1993): Probability, Narosa Publishing House.

9.

Johnson, N.L and Kotz, S.M. (1972): Distributions in Statistics, Vol. I , II & III. Houghton and Mifflin.

10.

David H.A (1981): Order Statistics, II Edition, and John Wiley.

11.

Feller W (1966): Introduction to probability theory and its applications, Vol. III, second edition. Wiley Eastern.

Subject Code	Subject Name	Credits Allotted		Total
APST-101	Probability and Distributions	Theory	Practical	4
		4	---	
Course Objective	1. To Explain about classes of sets and Probability measures 2. To discuss on random variables and convergence in probability and the important theorems with proofs. 3. To discuss about inequalities on expectations with their derivations and laws of numbers. 4. To explain about different discrete and continuous distributions and their Properties. 5. To learn about derivations and properties of various sampling distributions. 6. To explain order Statistics and their properties			
Course Out comes	1. Students must have knowledge about random variables, expectations, sets and their properties and inequalities where ever necessary. 2. Students also know the weak law, strong law and central limit theorem and their importance 3. Students know about different continuous and discrete distributions and their properties. 4. They have awareness about central and non central sampling distributions and order Statistics. Idea about simple, partial and multiple correlation coefficients.			

APST-102(A): Measure Theory and Linear Algebra

Unit-I

Field and Sigma Field. Measure and Probability Measure. Outer Measurability of Sets. Class of Measurable Sets. Construction of Outer Measure using Sequential Concerning Classes. Lebesgue Measure. Construction of Non-Measurable Sets.

Unit-II

Measurable Function as a Random Variable. Simple Functions. Sequences and Algebra of Measurable Functions. Approximation Theorem of Measurable Functions. Concepts of Almost Everywhere (a.e) and Almost Uniform Convergence. Egoroffs Theorem. Lusin Theorem.

Unit-III

Convergence in Measure. Fundamental in Measure. F.Riesz Theorem for Convergence in Measure. Integral of a Measurable Function w.r.t a Measure. Bounded Convergence Theorem. Fatou's Lemma, Monotone Convergence Theorem. General Lebesgue Integral and Lebesgue Dominated Convergence Theorem.

Unit-IV

Linear and Orthogonal Transformation of a Matrix. Eigen Values and Eigen Vectors of a Linear Transformation. Quadratic Forms and Their Reduction to Canonical Form. Signature of a Matrix. Positive Definite Matrix.

References

1. Graybill, F.A. (1983). Matrices with applications in statistics, 2nd ed. Wadsworth, Belmont (California).
2. Rao, C. R. (1985). Linear statistical inference and its applications, Wiley Eastern Ltd., New Delhi.
3. Searle, S. R. (1982). Matrix Algebra useful for Statistics, John Wiley and Sons. Inc.
4. Bellman, R. (1970), Introduction to Matrix Analysis, 2nd ed. McGraw Hill, New York.
5. Campbell, H.G. (1980), Linear Algebra with Applications, 2nd Edition, Prentice-Hall, Englewood Cliffs (new Jersey), 1980.
6. Biswas, S. (1984), Topics in Algebra of Matrices, Academic Publications.
7. Hadley, G. (1987), Linear Algebra, Narosa Publishing House.
8. Halmos, P.R. (1958), Finite-dimensional Vector Spaces 2nd ed. D.Van Nostrand Company, Inc.
9. Hoffman, K. and Kunze, R, (1971). Linear Algebra, 2nd ed., Prentice Hall
10. Rao, A.R. and Bhimasankaram, P. (1992), Linear Algebra, Tata McGraw Hill Publishing Company Ltd.
11. Rao, C.R. and Mitra, S.K. (1971), Generalized Inverse of Matrices and its Applications, John Wiley and Sons, Inc.
13. Narayan, S. (1970), Theory of Matrices, S. Chand & Company, New Delhi.

Subject Code	Subject Name	Credits Allotted		Total
APST-102(A)	Measure Theory and Linear Algebra	Theory	Practical	4
		4	---	
Course Objective	1. To Prepare Students about algebra of matrices and vector spaces. 2. To explain about roots vectors and linear transformations with an examples			
Course Out comes	Students understood for estimation of elementary transformations in matrix and their solutions. Students learnt about characteristic roots and vectors with numerical examples. They also know theoretical proofs of theorems.			

APST-102(B): Financial Statistics

Unit -I: Review and Extensions- Assets, Portfolios and Arbitrage, Derivatives, Pricing, Hedging, Greeks, Discrete Time Models, Continuous Time Models, Random walk, Geometric Random Walk, Brownian Motion, Wiener Process.

Unit -II: Review and Extensions- Stochastic Calculus, Stochastic Differential Equations, Partial Differential Equations, Black- Scholes' PDE, Martingales and their Applications in Pricing of Assets, Plain Vanilla Options, Greeks of Plain Vanilla Options, Estimation of Volatility, CRR Model.

Unit- III: Financial Markets Instruments- Exotic Options, Reflection Principle, Asian Options, Change of Numeraire, Pricing of Exchange Options, Forward Rates Modelling, Forward Vesicek Rates, Interest Rates Derivatives and their Pricing, Default Risk in Bond Markets, Credit Default Swaps.

Unit-IV: Jump Processes- Poisson Process, Compound Poisson Processes, Stochastic Integrals with Jumps, Itô- Integral with Jumps, Stochastic Differential Equations with Jumps, Girsanov Theorem for Jumps Processes, Lévy Processes, Pricing and Hedging in Jump Processes, Risk Neutral Measures, Black Scholes' PDE with jumps.

References

1. Lamberton, D. and Lepeyre, B. (2008). Introduction to Stochastic Calculus Applied to Finance, 2nd ed., Chapman and Hall/CRC Press.
2. Privault, N. (2014). Stochastic Finance –An Introduction with Market Examples, Chapman and Hall/CRC. Financial Mathematics Series, CRC Press, Boca Raton, 2014.
3. Tankov, P. (2010). Financial Modeling with Lévy Processes, e-Book.

Course Objectives: Financial Statistics aims to introduce students to the market tools required for analyzing the financial markets, to model various financial instruments and to find solutions of the problems faced by various players of these markets.

Course Learning Outcomes:

After successful completion of this course, student will be able to:

1. Understand the intricacies of the derivatives markets and analyse them quantitatively.
2. Model and analyze the jumps observed in security markets.
3. Take up research to be able to attempt to fill the gap between the markets and academics.

APST 103(A): Advanced Survey Sampling Theory

Unit I: Admissibility of Estimators; Non-existence of UMV estimators; Estimation of Median; Sampling on two or more successive occasions (Repetitive surveys); Re-Sampling techniques for variance estimation-independent and dependent random groups, the Jackknife and the Bootstrap.

Unit II: Small-area estimation; Design-based conditional approach; Double sampling for stratification.

Unit III: Non-sampling errors; Non-response and missing data; Randomized Response Techniques for one quantitative sensitive characteristic. Prediction of non-observed residual under fixed (design-based) and super-population (model-based) approaches.

Unit IV: Model-assisted sampling strategies; Different types of Super-population models with optimal strategies based on them; Robustness against model failures.

References

1. Cassel, C.M., Sarndal, C-E and Wretman, J.H. (1977). Foundations of Inference in Survey Sampling, John Wiley & Sons.
2. Chaudhari, A. and Stenger, H. (2005). Survey sampling Theory and Methods, 2nd ed., Chapman and Hall.
3. Hedayat, A.S. and Sinha, B.K. (1991). Design and Inference in Finite Population Sampling, John Wiley & Sons.
4. Muhopadhyay, P. (2007). Survey Sampling, Nerosa Publishing House, New Delhi.
5. Mukhopadhyay, P. (1996). Inferential Problems in Survey Sampling, New Age International (P) Ltd.
6. Levy, P.S. And Lemeshow, S. (2008). Sampling of Populations-Methods and Applications, John Wiley & Sons.
7. Sarndal, C.E., Swensson, B. and Wretman, J.H. (1992). Model Assisted Survey Sampling, Springer-Verlag.

8. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press, Iowa, USA.

9. Wolter, K.M. (2007). Introduction to Variance Estimation, Springer-Verlag.

Course Objectives: The objective of this course is to provide advanced techniques in survey sampling with practical applications in daily life and to provide accessible statistical tool for applying sampling strategies and methodologies.

Course Learning Outcomes:

After successful completion of this course, student will be able to:

1. Understand the non –existence of uniform estimators and repetitive surveys.
2. Apply the re-sampling techniques for variance estimation – independent and dependent random groups.
3. Understand the design based estimation procedures and double sampling technique for stratification.
4. Understand the response and non- response techniques; Randomized Response Technique and a technique to predict non observed residue under design and model based model.
5. Understand the model assisted sampling strategies; super population model.

APST 103(B): Statistical Methodology

Unit I: Brief review of basic distribution theory, Symmetric distributions, Truncated distributions, Compound distributions, Mixture of distributions, Generalized power series distributions, Exponential family of distributions.

Unit II: Characterization of distributions (Geometric, negative exponential, normal, gamma), Non-central Chi-square, t and F distributions and their properties, Concept of censoring. Approximating distributions, Delta method and its applications, Approximating distributions of sample moments, Limiting moment generating function, Poisson approximation to negative binomial distribution.

Unit III: Order statistics-their distributions and properties. Joint and marginal distributions of order statistics. Extreme values and their asymptotic distributions (statement only) with applications. Tolerance intervals, coverage of $(X(r), X(s))$. General theory of regression, fitting of polynomial regression by orthogonal methods, multiple regression, examination of regression equation.

Unit IV: Robust procedures, Robustness of sample mean, Sample standard deviation, Chisquare test and Student's t-test. Sample size determination for testing and estimation procedures (complete and censored data) for normal, exponential, Weibull and gamma distributions.

References:

1. Arnold, B.C., Balakrishnan, N., and Nagaraja, H.N. (1992). A First Course in Order Statistics, John Wiley & Sons.
2. Biswas, S. (1992). Topics in Statistical Methodology, Wiley-Blackwell.
3. David, H.A., and Nagaraja, H.N. (2003). Order Statistics, 3rd Edn., John Wiley & Sons.
4. Dudewicz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, Wiley, International Students' Edition.
5. Huber, P.J. (1981). Robust Statistics, John Wiley & Sons.
6. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). Discrete Univariate, John Wiley & Sons.
7. Johnson, N.L., Kotz, S. and Balakrishnan, N. (2000). Continuous Univariate Distributions, John Wiley & Sons.
8. Mukhopadhyay, P. (2015). Mathematical Statistics. New Central Book Agency.
9. Rohatgi, V.K. and Saleh, A. K. Md. E. (2005). An Introduction to Probability and Statistics, 2nd Edn., John Wiley & Sons.
10. Rohatgi, V.K. (1984). Statistical Inference, John Wiley & Sons.
11. Rao, C.R. (1973). Linear Statistical Inference and Its Applications, 2nd Edn., John Wiley & Sons.

Course Objective: The aim of this course is to provide a thorough theoretical grounding in different type of distributions, non-central distributions, censoring, delta method, robust procedures etc.

Course Learning Outcomes:

After successful completion of this course, student will be able to:

1. Formulate the mathematical/statistical models for real data sets arising in various fields in order to analyse in respect of various useful characteristics of the populations.
2. Understand how to use non-central distributions in real life problems.
3. Understand different types of censoring schemes.
4. Work with incomplete data which is a challenging problem in today's life.

APST 104: Practical-I (APST 102 & APST 103)

APST 105(A): Statistical Analysis using Excel and SPSS

Unit-I: Review of Excel, sorting, filtering and construction of charts. Curve fitting and interpretation of the output. Statistical functions in Excel - Calculating theoretical probability using Binomial, Poisson and Normal distributions. Matrix operations- Transpose, Product and Inverse operations using Excel. Pivot tables and look up functions.

Unit-II: Data Analysis Pak in Excel, descriptive statistics, tests of hypothesis, ANOVA, Correlation and Regression, Random Number Generation from different distributions, Binomial, Poisson, Uniform, Normal and from discrete distributions with given mean and variance. Forecasting Using Excel – Moving Averages and Exponential Smoothing, Use of functions, Linest, Logest, Forecast, Growth, Trend for trend analysis. The use of solver for optimization – Application to LPP.

Unit-III: Introduction to SPSS, Different Menu's in SPSS, creating a data file, opening excel files, variables and labels, selecting cases by filtering, recoding of data, merging of files, Sorting of Cases and Variable, SPSS Output and its transfer to excel and word. Analysis categorical data- Scales of Measurements, Data reliability-test rest method, Cronbach's alpha.

Unit-IV: Using SPSS Analysis tools, descriptive statistics, cross tabs (with stress on procedures and syntax). Post-hoc analysis for multiple comparisons using Tukey's test, Duncan's Multiple Range Test, Dunnett's test and Scheffe's test with interpretation. Selection of variables in Multiple Linear Regression – stepwise procedures and analysis of residuals. Procedure for Binary Logistic regression, Factor analysis, Linear Discriminant analysis and Cluster analysis.

APST 105(B): Statistical Computing and Data Analysis

Unit-I: Review of programming in C: Operators & expressions; Flow control; Functions; Arrays; Strings; Pointers; Structures. Computer representation of numbers, Errors. Bitwise operations. The C Preprocessor, Macros. Linked Lists; Stacks & Queues. Sorting – Introduction, bubble sort, selection sort, insertionsort, quick sort.

Unit_II: Random numbers: Pseudo-Random number generation, tests. Random variable generation, Inverse-Transform method, Composition Method, Acceptance-Rejection Method. Generating discrete and continuous random variables.

Unit-III: Simulation- Random Walk. Applications relating to the problems based on other courses viz., Probability Theory, Statistical Methodology, Survey Sampling.

Unit – IV: Data Analysis

Computer-based data analysis of problems.

References

1. Gottfried, B.S. and Chhabra, J.K. (2006). Programming with C, Tata McGraw Hill Publishing Co. Ltd., New Delhi (SIE).
2. Knuth, D.E. (2002). The Art of Computer Programming, Vol. 2/Semi numerical Algorithms, Pearson Education (Asia).
3. Kernighan, B.W. and Ritchie, Dennis M. (1989). The C Programming Language, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Rubinstein, R.Y. (2017). Simulation and the Monte Carlo Method, 3rd ed., John Wiley & Sons.
5. Ross, S.M. (2012). Simulation, 5th ed., Academic press.
6. Thareja, R. (2014). Data Structures using C, Oxford University Press, New Delhi, India.

List of Practicals:

1. Study of convergence of sequence through plotting.
2. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
3. Evaluating line integral and multiple integral.
4. Program to discuss the algebra of complex numbers.
5. To perform contour integration.
6. To plot the complex functions and analyse the graph.
7. To perform Taylor series and Laurent's series expansion of a given function $f(z)$ around a given point z .
8. To compute poles and corresponding residue of complex function of sets.
9. To examine whether a given function is measurable or not.
10. To find out Lebesgue- Stieltjes measure of a given real valued function of a real variable.
11. To find out marginal distribution function of random variables X and Y when some distribution function $f(X, Y)$ is given.
12. To check a sequence of set for convergence and to find out limit of the sequence if exists.
13. To find the limit inferior and limit superior of a given sequence of sets.
14. To check whether a given sequence of random variables $\{X_n\}$ is uniformly integrable or not.
15. For a sequence of random variables check whether $E(\lim X_n) = \lim E(X_n)$ holds or not.
16. Problems based on censoring.
17. Problems based on maximum likelihood estimation.
18. Problems based on tolerance intervals.
19. Random number generation from non-central Chi square distribution.
20. Random number generation from non-central t-distribution.
21. Random number generation from non-central F-distribution.
22. Problems based on sample size determination for testing.
23. To select simple random Sample with and without replacement and estimate population mean and population variance for a given sample size.
24. To select Stratified Random Sample for a given population.
25. Allocation of sample using proportional and Neyman method of allocation and comparing their efficiencies relative to SRS.
26. Systematic Sampling.
27. To estimate population mean in case of sampling with varying probabilities of selection.
28. Cluster Sampling.
29. Two- stage Sampling.

APST 106(A): Applied Stochastic Process and Review Theory

UNIT -I

Introduction to stochastic process (SP) – classification of SP according to state space and time domain. countable state markov chain (MC). Chapman- Kolmogorov equations. Calculation of 'n' step transition probability.

UNIT -II

Discrete state space – continuous time MC. Kolmogorov differential equations. Poisson process, birth and death process .Application to queues and storage problem. Random walk.

UNIT -III

Markov process – continuous time and continuous state space - time homogenous markov process – Kolmogorov's equation. Wiener process as a limit of random walk, first passage time Diffusion process with Wiener process.

UNIT -IV

Stationary process and time series- wide sense and strict sense stationary process – moving average and auto regressive process. Covariance function - Bochner's function (statement), Khintchine's representation of wide sense stationary process. Renewal theory – renewal function and its properties – Elementary and key renewal theorems.

References

1. Medhi.J. (1982) Stochastic process, Wiley Eastern.
2. Basu. A.K. (2003) Introduction to stochastic processes, Newsa Publishing House.
3. Ross. S.M. (1983) Stochastic Process, Wiley, New York.
4. Karlin and First course in Stochastic Process-Vol.I&II, Academic Press. Taylor.H.M. (1975)

APST 106(B): STATISTICAL COMPUTING

UNIT- I: Object Oriented Programming (OOPs) Paradigm – Basic Concepts of OOPs – Object Oriented Languages. A Simple C++ Program – More C++ Statements – Structure of C++ Program. Tokens, Keywords – Identifiers and Constants – Basic Data Types – User-defined Data Types – Operator in C++ – Scope Resolution Operator – Expressions and their Types – Control Structures.

UNIT –II: Functions in C++: Introduction – The main function – Function Prototyping – Inline Functions – Default Arguments – Function Overloading – Math Library Functions. Classes and Objects: Specifying a Class – A C++ Program with Class – Defining Member Functions – Nesting Member Functions – Private Member Functions – Arrays within a class – Friendly functions – Memory Allocation of Objects – Array of Objects – Local Classes.

UNIT –III: Constructors – Copy Constructor – Dynamic Constructors – Constructing Twodimensional Arrays, Destructors. Operator Overloading – Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Rules for Overloading Operators. Function Overloading – Function Overloading with Arguments – Special Features of Function Overloading.

UNIT – IV: Inheritance: Introduction – Types of Base Classes – Types of Derivation – Public – Private – Protected – Defining Derived Classes –Single Inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance – Polymorphism – Introduction – Virtual Functions. Managing Console I/O Operations: C++ Streams – C++ Stream Classes – istream, ostream, iostream, fstream, ifstream, ofstream, filebuff. Unformatted I/O Operations – Formatted I/O Operations –Managing output with Manipulators. Classes for File Stream Operations – Opening and Closing a file – Detecting end-of-file.

References:

E. Balagurusamy: Object Oriented Programming with C++, Tata McGraw-Hill Publishing Company Limited, New Delhi, 4th Edition, 2008.

APST 107: Practical-II (APST 105 & APST 106)

APST 108: OOTC

APST 109: Research Methodology

UNIT – I: Introduction to Research: Meaning and importance of Research, Types of Research, Research Design and Stages Selection and Formulation of Research Problem, Objective(s) and Hypothesis Developing Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Design. Data Collection: Sources of Data – Primary and Secondary, Types of Data – Categorical (nominal and ordinal), Numerical (discrete, continuous, ratio and interval) Methods of Data Collection: Survey, Interviews (in-depth or Key Informant interviews), Focus Group Discussion (FGD), Observation, Records or Experimental Observations.

UNIT – II: Data Processing and Analysis: Statistical Graphics – Histograms, Frequency Polygon, Ogive, Dotplots, Stemplots, Bar Graphs, Pareto Charts, Pie Charts, Scatterplots, Boxplots Descriptive Analysis – Frequency Distributions, Measures of Central Tendency, Measures of Variation/Dispersion, Skewness and Kurtosis, Measures of Relative Standing Qualitative Approaches Including Grounded Theory, Ethnography, Narrative Inquiry, Phenomenology and Case-Study.

UNIT – III: Scientific Writing & Research Ethics: Structure and Components of Scientific Reports – Types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, Structure and Language of Typical Reports – Illustrations and Tables – Bibliography, Referencing and Foot Notes.

UNIT-IV: Preparation of the Project Proposal : Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and Work Plan – Budget and Justification – References. Research Ethics Committees/Institutional Review Board – Roles and Importance Intellectual Property rights – Commercialization, Royalty Reproduction of Published Material – Citation and Acknowledgement, Plagiarism.

SEMESTER- II								
S.no	Course	Code	Tittle of the course	H/W	C	SEE	IA	TOTAL Marks
01	CC	APST 201	Multivariate & System Analysis	4	4	70	30	100
02		APST 202	A: Design and Analysis of Experiments B: Actuarial Statistics	4	3	50	25	75
03		APST 203	A: Theory of estimation B: Industrial Statistics	4	3	50	25	75
04	P	APST 204	Practical – III (202 & 203)	6	2	35	15	50
05	SOC	APST 205	A: Applied Regression Analysis B: Optimization Techniques	4	3	50	25	75
06		APST 206	A: Statistics and Quality Control B: Official Statistics	4	3	50	25	75
07	P	APST 207	Practical – IV(205 & 206)	6	2	35	15	50
08	OOTC	APST 208	Online course	--	2	--	--	--
09	Audit Course	APST 209	Advanced Analytical Skills	4	0	0	0	0
Total				36	22	340	160	500

APST-201: Multivariate & System Analysis

Unit-I: Multivariate normal distribution - definition and properties including marginal and conditional distributions, random samples from multivariate normal distribution, sample mean vector and sample dispersion matrix.

Unit-II: Multiple and Partial correlation, Canonical correlations and variables - definition & computations. Tests based on total, partial and multiple correlations and Fisher's Z transformation.

Unit-III: Wishart Distribution: Definition and important properties, Derivation of Wishart distribution, Joint distribution of mean vector and co-variance matrix, Results associated with Wishart distribution. Sample generalized variance and its asymptotic distribution.

Unit-IV: Tests on mean vectors - Hotelling's T^2 for one & two sample cases. D^2 statistics and their null and non-null distributions. Classification and discriminant between two multivariate normal populations. Probability of misclassification and their estimation. Principle components, dimension reduction, sample principle components.

Outcomes: Upon successful completion of this course, students should know about the multivariate generalized distributions like multivariate normal distribution and Wishart distribution. Students will also be able to apply and identify different multivariate techniques for analyzing the data.

Objectives: The main objective of this course is to find patterns and relationships between several variables simultaneously. Multivariate Analysis lets us to predict the effect of a change in one variable will have on other variables. Multivariate analysis is a decisive advantage over all other forms of analysis.

Course Contents:

Books:

1. Anderson, T.W. (1983): An Introduction to Multivariate Statistical Analysis; John Wiley.
2. Johnson and Wichern (1992): Applied Multivariate Statistical Analysis.
3. Khirsagar, A.M. (1972): Multivariate Analysis; Marcel Dekker.
4. Muirhead, R.J. (1982): Abstracts of Multivariate Statistical theory; John Wiley.
5. Seber, G.A.F. (1984): Multivariate Observations : John Wiley.
6. Srivastava and Khatri (1979): An Introduction to Multivariate Statistics : North Holland.
7. Johnson and Wichern (1972): Continuous Multivariate Distribution, John Wiley.
8. Rao C.R. (1973) : Linear Statistical Inference and its applications, Second Edition, Wiley.
9. Mardia, K.V., Kent J.T. and Bibby I.M. (1979): Multivariate Analysis.
10. Srivastava M.S. and Carter E.M. (1983): An Introduction to applied multivariate statistics, North Holland.
11. Morrison D.F. (1979): Multivariate statistical method, second edition, McGraw-Hill.

APST-202(A): Design and Analysis of Experiments

Unit-I: Linear Model; Estimability of linear parametric functions; BLUE, Gauss-Markoff theorem; Generalized Gauss-Markoff theorem, ANOVA model, ANOVA for Two way and three way classifications, ANCOVA technique for one way and two-way classifications. Multiple comparisons tests using Tukey's, Duncans, Sheffe's and Dunnet's tests.

Unit-II: Latin squares and their construction, Mutually orthogonal Latin squares; Missing plot technique in Latin square Design, Graeco-Latin square Design; Analysis of Factorial Experiments involving factors with two and three levels in randomized blocks.

Unit-III: Necessity of confounding, Types of confounding, complete and partial confounding in 2^n , 3^2 and 3^3 factorial designs, Analysis of confounded factorial designs; Fractional Replication, Split Plot design.

Unit-IV: Incomplete Block Designs; B I B D, Inter and Intra Block analysis of a BIBD, Types of BIBD, construction of BIBD's using Mutually orthogonal Latin squares; Concepts of Youden square and lattice Design, Two-Associate PBIB design, Analysis of P B I B design.

References

1. M.N. Das and N.C.Giri (1979), Design and Analysis of Experiments, Wiley, Eastern, Pvt. Ltd., New Delhi.
2. C.D. Montgomery (1976), Design and Analysis of Experiments, Wiley & Sons, New York

3. M.C.Chakbravorthy, (1962), Mathematics of Design of Experiments, Asia Publishing House, Calcutta.
4. Oscar Kempthorne (1974), The Design and Analysis of Experiments, Wiley Eastern, Pvt. Ltd., New Delhi.
5. W.T. Federer (1972), Experimental Designs Theory and Application, Mac Millan Company, New York.
6. Angela Dean and Daniel Ross (1999), Design and Analysis of Experiments, Springer-Verlag.
7. D.D.Joshi (1987), Linear Estimation and Design of Experiments, Wiley Eastern, Pvt. Ltd., New Delhi.
8. P.W.M.John (1971), Statistical Design and Analysis of Experiments, Macmillan
9. F.Pukelshiem (1993), Optimal Design of Experiments, Wiley & Sons
10. D.Raghava Rao (1971), Construction and combinatorial problems in Design of Experiments, Wiley & Sons
11. Aloke Day (1986), Theory of Block Designs, Wiley Eastern, Pvt. Ltd., New Delhi.

Subject Code	Subject Name	Credits Allotted		Total
		Theory	Practical	
APST 202(A)	Design and Analysis of Experiments	4	----	4
Course Objective	1. To learn ANOVA and ANCOVA for one and two way classifications analysis and their multiple comparison tests. 2. To explain Latin squares, different types of Latin squares and their missing plots. 3. To discuss on Confounding, their types, confounding 2^n, 3^2 and 3^3 factorial designs etc. 4. To discuss about BIBD, PBIBD construction analysis.			
Course Out comes	1. Students learnt ANOVA, ANCOVA technique for one way and two-way classifications. Multiple comparisons tests using Tukey's, Duncans, Sheffe's and Dunnet's tests. 2. Students understood about Latin squares and their construction, missing plot technique etc. 3. Students explained about Incomplete Block Designs and their analysis, etc.			

APST-202(B): Actuarial Statistics

UNIT-I: Theory of Interest rates: Rate of interest; Nominal rate of interest. Accumulation factors. Force of interest, present values, Stoodley's formula for the force of interest, present value of cash flows, valuing cash flows. Basic compound interest function, equations of values and yield on transaction-annuities certain, present values and accumulation, concepts of different annuities, continuously payable annuities, varying annuities.

UNIT-II: Utility theory, insurance and utility theory, models for individual claims and their sums, Approximations for the distribution of the sum. Application to insurance. Survival function Time until-death for a person aged x , curate future lifetime, force of mortality. Life table and its relation with survival function, examples, the deterministic survivorship group, recursion formulas, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables.

UNIT-III: Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, Life annuities: Single payment, continuous life annuities, discrete life annuities, Life annuities with m^{th} monthly payments, recursions, complete annuities-immediate and apportionable annuities-due.

UNIT-IV: Multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions, evaluation for special mortality laws. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrements, central force assumptions for multiple decrements. Uniform distribution assumption for multiple decrements.

Course Outcomes:

- 1: Able to learn the concept of interest, different terminologies like loss function, net premium and life annuities.
- 2: Able to understand the utility and insurance theory and life tables.
- 3: To understand the concept of life insurance and the existing insurance products of different insurance companies.
- 4: Able to learn the concepts of death - level benefit insurance, endowment insurance, differed insurance, varying benefit insurance, claim amount distribution.
- 5: Able to acquire knowledge different life functions.

Course Specific Outcomes:

- CSO1: Able to understand the concept of life insurance and existing products of different insurance companies.
- CSO2: Enrich about the awareness about the status of health and life insurance.
- CSO3: To learn about the associated business through insurance policies.
- CSO4: To apply mathematical and statistical methods to assess risk in the insurance and finance industries.

Learning Outcomes:

- LO1: Learn the mechanisms of life and health insurance.
- LO2: Get expertise in the probability models that can be designed for aggregate values of population survival.
- LO3: When uncertainty involved, student can develop and analyse actuarial models with the help of probability theory, statistics and economic theories.
- LO4: Able to design the insurance policies.

Text Books:

N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A.Jones and C.J.Nesbitt, (1986): Actuarial Mathematics, Society of Actuaries, Ithaca, Illinois, U.S.A.Second Edition (1997)
Chapters: 1,2,3,4,5,9 &10
J.J.McCutcheon and W.F.Scott: An Introduction to Mathematics of Finance, Butter Worth & Heinemann

Reference Books:

Spurgeon E.T.(1972): Life Contingencies, Cambridge University Press.
Neill A (1977) Life Contingencies, Heinemann

APST-203(A): Theory of estimation

Unit-I: Parametric models, likelihood function; examples from standard discrete and continuous models. Information in data. About the parameters as variation in likelihood function, concept of no information, sufficiency, Neyman factorizability criterion, likelihood equivalence. Fisher information for single and several parameters.

Unit-II: Minimal sufficient statistic, Exponential families and Pitman families. Minimum Variance Unbiased Estimation, unbiasedness, locally unbiased estimators, minimum variance, locally minimum variance, mean squared error, Cramer-Rao lower bound approach. Minimum variance unbiased estimators(MVUE), Rao-Blackwell theorem, completeness, Lehman-Scheffe theorem, necessary and sufficient condition for MVUE.

Unit-III: Consistent estimation of real and vector valued parameter, invariance of consistent estimator under continuous transformation: Consistency of estimators by method of moments and method of percentiles, mean squared error criterion, Asymptotic relative efficiency. Consistent asymptotic normal (CAN) estimator.

Unit-IV: Method of Maximum Likelihood: notion, MLE in exponential family, Cramer Family, Multinomial with all probabilities depending on a parameter, solutions to likelihood equations, method of scoring, Newton-Raphson and other iterative procedures. Fisher lower bound to asymptotic variance, extension to multiparameter case (without proof).

Course Outcome

CO1: To apply various estimation and testing procedures to deal with real life problems.

CO2: To understand Fisher Information, Lower bounds to variance of estimators, MVUE and apply them in practical situations.

CO3: To understand consistency, sufficiency, unbiasedness, CAN and BAN estimators

References:

1. Casella G. and Berge R.L. (2002): Statistical Inference, 2nd Ed., Thomson- Duxbury, Singapore.
2. Kale B.K. and Muralidharan (2015): Parametric Inference, An Introduction, Alpha Science International Limited.
3. Kendall M.G. and Stuart A. (1968): The Advanced Theory of Statistics, Vol.II, Charles Griffin and Co.
4. Lehman E.L. (1986): Theory of Point Estimation, John Wiley.
5. Rao C.R. (1973): Linear Statistical Inference and Its Applications. Wiley Eastern.
6. Rohatgi V.K. and A.K.L. Salah (2001): An Introduction to Probability and Mathematical Statistics. Wiley Eastern.
7. Silvey S.D. (1970): Statistical Inference. Chapman and Hall.
8. Zacks S. (1981): Parametric Statistical Inference, Pergamon Press

APST-203 (B): Industrial Statistics

UNIT-I: Management of quality control: SQC as an aid for management quality planning, quality costs, idea of total quality control approach, concept of Six-Sigma. Cumulative sum control charts (CSCC): Basic principles, derivation of ARL, application of CSCC for mean, standard deviation, fraction defective and number of defects per unit.

UNIT-II: Tabular CSCC for mean, variability, standardized tabular CSCC. V-mask scheme. EWMA control chart. Moving average control chart. Comparison of these charts with Shewhart charts.

UNIT-III: Process capability analysis: Determining the process capability using $\bar{X}$, R charts. Process capability ratio (PCR). The role of normality in determining defective parts per million. One sided specification, non-normal distributions. Chain sampling plans, continuous sampling plans, Skip-lot sampling plans.

UNIT-IV: Use of design of experiments in process development and improvement: 2^k -factorial design with 2^{k-1} fractional factorial design. Taguchi's contribution to quality engineering: Elements and principle of quality engineering. Steps in robust design; signal to noise ratio. $k \geq 1$ $k \leq 2$

Objectives: This course aims to create to successfully applying statistical techniques such as Shewhart control chart, cumulative-sum control chart, process capability analysis, design of experiments, chain sampling etc. to many different areas of research for industry.

Outcomes: Upon completion of this course, the students will be able to apply various statistical methods included in this course to improve the quality of the products used by our society and process improvement in industry.

Books:

1. Montgomery, D.C. (1985): Introduction to Statistical Quality Control, Wiley.
2. Montgomery, D.C. (1985): Design and Analysis of Experiments; Wiley.
3. Rayon, T.P. (1989): Statistical Methods for quality improvement. John Wiley and sons.
4. Ott, E.R. (1975): Process Quality Control ; McGraw Hill.
5. Wetherill, G.B. (1977): Sampling Inspection and Quality Control, Springer.
6. Phadke, M.S. (1989): Quality Engineering through Robust Design; Prentice Hall.
7. Wetherill, G.B. and Brown, D.W. (1991): Statistical Process Control, Theory and Practice; Chapman and Hall

APST-204: Practical – III (202 & 203)

APST-205(A): Applied Regression Analysis

Unit-I: Multiple Regression Model: Estimation of regression coefficients. Regression analysis of variance. Fitted values of residuals. Residual plots as test of departure from assumptions such as fitness of model, normality. Selection of explanatory variables, Mallows C_p statistic. Test for regression coefficients.

UNIT-II: General least square model: Estimation of parameters. Heteroscedasticity and its effect in estimation. Tests for heteroscedasticity. Multi-collinearity, Remedial measures to tackle the problem of multi-collinearity.

UNIT-III: Auto-correlation for disturbance terms. consequences of auto-correlation. Durbin-Watson test for first order auto-correlation. Remedial measures to tackle the problem of auto-correlation. Dummy Variables: Salient features of dummy variable method, applications of dummy variables in linear model.

Unit-IV: Logistic regression: logit transformation, ML estimation, Wald test, Score test. System of Simultaneous linear equations: Concept of structural and reduced forms. Problem of identification. Rank and order conditions. Methods of estimating parameters: Indirect least square method and two stage least square method.

Objectives: To provide an understanding for the students on regression analysis and multiple regression. To provide deep knowledge of different criterion like heteroscedasticity, multicollinearity etc. arises in general linear model. To provide knowledge to construct an appropriate linear model.

APST-205(B): Optimization Techniques

Unit-I: Linear Programming Problem: basic feasible solution, graphical method, Standard form of an LPP, Simplex method of solving an LPP, Fundamental Theorem of an LPP, Two-phase method and Big-M method, degeneracy, duality in LPP, Fundamental Theorem of Duality and Integer LPP (branch and bound method only).

Unit-II: Assignment problem, Hungarian method of assignment, transportation problem: basic feasible solution (North-West Corner Method, Least Cost Method and VAM Method) methods of finding optimum solution, degeneracy in transportation problem. Replacement models: Types of failure, replacement of items deteriorates with time, replacement of items that fail completely.

Unit-III: Non-linear programming: General non-linear programming problems - Constrained optimization with equality and inequality constraints, Kuhn – Tucker conditions (statement only) and applications. Dynamic programming - Characteristics of dynamic programming problem, different models - Single additive constraint and multiplicative separable return, single additive constraint and additively separable return, single multiplicative constraint and additively separable return, dynamic programming approach for solving a LPP.

Unit-IV: Queueing Theory: Characteristics of queueing processes, role of Poisson distribution and exponential distribution in queueing theory, steady state solution of M/M/1 model, Waiting time distribution of M/M/1 model, steady state solution of M/M/C model and steady state solution of M/EK/1 queueing model, measures of effectiveness of these models.

Text Books:

1. Gross, D. and Harris, C.M. (2009). Fundamentals of Queueing Theory, John Wiley & Sons.
2. Kanthi Swarup, Gupta, P.K, and Man Mohan (2012). Operations Research, Sulthan Chand & Sons.
3. Sharma, J.K. (2009). Operations Research Theory and Applications, Macmillan India Limited

References:

1. Medhi J (2014) Introduction to Queueing Systems and Applications, New Age International Publishers
2. Mittal, K.V. and Mohan, C. (1996). Optimization Methods in Operations Research and System Analysis, New Age Publishers.
3. Paneerselvam, R. (2006). Operations Research, Prentice hall of India.
4. Rao S S. (1984), Optimization Theory and Applications, New Age Publishers, Wiley Eastern.
5. Ravindran, A., Philips, D.T. and Solberg, J. (2007). Operations Research: Principles and Practice, John Wiley & Sons, New York.
6. Taha, H. A. (2010). Operations Research, Macmillan India Limited

APST-206(A): Statistics and Quality Control

UNIT-I: General Theory of Control Charts: Control charts for attribute and variables: O.C. and A.R.L. of control charts; control by gauging; Moving average and exponentially weighted moving average charts; Cu-sum charts using V-masks and decision intervals. Capability indices: Cp, Cpk and Cpm.

UNIT-II: Acceptance sampling plans for attribute inspection: Single, double and sequential sampling plans; Plans for inspection by variables for one-sided and two-sided specifications;

UNIT-III: Mil Std and ISI plans; Continuous sampling plans of Dodge type and Wald-Wolfwitz type and their properties.

UNIT-IV: Industrial Experimentation, Fractional factorial experiments, Response surface methodology, Six sigma in process improvement and product development, Lean thinking, Value stream analysis, 5 s.

Course Outcomes:

- 1: Able to understand basics of production process monitoring and apply concept of control charts to it.
- 2: Apply acceptance and continuous sampling plan in production process.
- 3: Able to construct sampling inspection plans for attributes and variables.
- 4: Able to learn some advanced control charts and capability indices.
- 5: Able to construct Six Sigma limits.

Course Objectives:

- 1: Can identify the cause of defects using statistical quality management techniques.
- 2: Able to apply statistical quality control techniques to minimise the variability in manufacturing and business process.
- 3: Acquainted with Six Sigma and lean thinking in industrial experimentation.
- 4: Expertise in the most import field of applied statistics that contributes to quality control in all most all industries.

Reference Books:

1. Cowden D J (1957): Statistical Methods in Quality Control. 1st Edition. Prentice-Hall Inc.
2. Duncan Acheson (1986): Quality Control and Industrial Statistics. 5th Edition. IrvinMittag and Rinne (1993): Statistical Methods for Quality Assurance. 2nd Edition. Chapman and Hall Ltd.
3. Montgomerv. D.C (2012): Introduction to Statistical Quality Control. 7th Edition. John Wiley and Sons
4. R.C. Guptha(2001): Statistical Quality Control. 9th Edition. Khanna Publishers.
5. Ott, E.R. (1975): Process Quality Control. 4th Edition. McGraw Hill
6. Phadke, M.S. (1989): Quality Engineering through Robust Design. 1st Edition. Prentice Hall
7. Wetherill, G.B. (1977): Sampling Inspection and Quality Control. 2nd Edition. Chapman and Hall Ltd.
8. Wetherill, G.B. and Brown, D.W.(1991): Statistical Process Control. Theory and Practice. 3rd Edition. Chapman & Hall Ltd.

APST-206(B): Official Statistics

UNIT-I : Introduction to Indian and International statistical systems. Role, function and activities of Central and State statistical organizations. Organization of large scale sample surveys. Role of National Sample Survey Organization. General and special data dissemination systems.

UNIT-II : Population growth in developed and developing countries, evaluation of performance of family welfare programmes, projections of labour force and manpower. Scope and content of population census of India.

UNIT-III: System of collection of Agricultural Statistics. Crop forecasting and estimation, productivity, fragmentation of holdings, support prices, buffer stocks, impact of irrigation projects.

UNIT-IV: Statistics related to industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics.

Course Objectives:

CO1: Understanding the functioning of official statistics.

CO2: Search, evaluation and use of metadata and ability to judge the quality of data on this basis

CO3: Give exposure to Population growth in developed and developing countries and its challenges

CO4: To familiar with the Statistics related to society

REFERENCE BOOKS:

1. Basic Statistics Relating to the Indian Economy (CSO) 1990.
2. Guide to Official Statistics (CSO) 1999.
3. Statistical System in India (CSO) 1995.
4. Principles and accommodation of National Population Censuses, UNESCO.
5. Panse, V. G., Estimation of Crop Yields (FAO).
6. Family Welfare Yearbook. Annual Publication of D/o Family Welfare.
7. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt.

APST-207: Practical – IV(205 & 206)**APST-208: OOTC****APST-209: Advanced Analytical Skills**

UNIT-I : Integral Transforms: Fourier transform for solution of ODEs and PDEs, Laplace transform for solution of ODEs and PDEs. Partial Differential Equations: solution of linear PDEs including special cases of heat conduction equation and Navier--Stokes equation, solution of PDEs in cylindrical and spherical coordinate systems.

UNIT-II :First-order integral equations: Fredholm, Volterra and Wiener-Hopf equation, power series solution for integral equations, integral equations as a generalization of eigenvalue equations and connection to inverse problems.

UNIT-III: Linear Algebra: spaces and subspaces, positive definiteness and singular value decomposition (best basis), transformations and change of basis, pseudoinverse, eigenvalues and eigenvectors, introduction to multigrid, Krylov subspaces and conjugate gradients methods for solving large linear systems.

UNIT-IV: Statistical Methods: probability, random variables, discrete and continuous probability distributions, autocorrelation and cross correlation, Monte-Carlo method for the solution of diffusion equation, radiative transfer equation and collimated beam radiation problem; linear regression and curve fitting.

Text Books:

1. B. Dasgupta, Applied Mathematical Methods, Pearson Education, 2006.
2. Sheldon M Ross, Probability and Statistics for Engineers and Scientists, 5/e, Academic Press, 2014.

References:

1. M D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson India, 2007.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, International 10th Revised Edition, 2015.
3. G. Strang, Linear Algebra and Its Applications, Thomson, Brooks/Cole, 2006
4. P. V. O'Neil, Advanced Engineering Mathematics, CENGAGE Learning,, 2011.
5. R. L. Thomas and G. B. Finney, Calculus and Analytic Geometry, 11/e Addition Wisley Reading, 2010.
6. M. L. Boas, Mathematical Methods in the Physical Sciences, 3rd Ed, Wiley India, 2009.
7. A. D. Polyanin and A. V. Manzhirov, Handbook of Integral Equations, Second Edition, Chapman & Hall/CRC Press, Boca Raton, 2008.

SEMESTER- III								
S.no	Course	Code	Title of the course	H/W	C	SEE	IA	TOTAL Marks
01	CC	APST 301	Applied Econometrics	4	4	70	30	100
02		APST 302	A: Advanced Bio Statistics B: Theory of Point Estimation	4	3	50	25	75
03		APST 303	A. Reliability and Survival Analysis B: Statistical Testing in Data Analysis	4	3	50	25	75
04	P	APST 304	Practical – V (302 &303)	6	2	35	15	50
05	SOC	APST 305	A: Applied Operations Research B: Computer Programming C++	4	3	50	25	75
06		APST 306	A: LINEAR MODELS AND REGRESSION ANALYSIS B: Total Quality Management and Six sigma	4	3	50	25	75
07	P	APST 307	Practical – VI (305 and 306)	6	2	35	15	50
08	OOTC	APST 308	OOTC	--	2	--	--	--
*	Seminar/Tutorials/Remedial Classes and Quiz as part of Internal Assessment			4	0	0	0	0
			Total	36	22	340	160	500

APST-301: Applied Econometrics

Unit-I: Quick review of inference in classical linear regression model; Estimation and tests of significance of linear and compound growth rates; Incremental analysis; Testing the function form of regression; choosing between linear and log-linear regression models; Likelihood Ratio, Wald and Lagrange Multiplier tests.

Unit-II: Multicollinearity; Sources, consequences and detection of Multicollinearityl Farrar-Glauber test; remedial measures; Heteroscedasticity: Sources and consequences; Tests for Heteroscedasticity; Glejser’s test, Goldfield-Quandt test and Breusch-Pagan-Godfrey test; Estimation of parameters under Heteroscedasticity;

Unit-III: Autocorrelation; sources and consequences; first order autoregressive scheme; tests for autocorrelation Durbin-Watson test; Remedies; Estimation of parameters under Autocorrelation; Stochastic Regressors; Errors in variables linear model, IV and ML methods of estimation.

Unit-IV: Finite distributed lag models; Almon's Polynomial approach; Infinite distributed lag models; Geometric lag model; Koyck's approach; IV method; simultaneous linear equations models; Problem of identification; Indirect least squares, LIML, Two stage least squares; three stage least squares and FIML estimation methods.

References:

1. Johnston, J (1984): Econometric Methods, III rd edition , MC Graw Hill.
2. Judge, C.G., Griffiths, and Hill, R.C. et al (1985): Theory and Practice of Econometrics, John Wiley.
3. Gujarathi, D. (1979): Basic Econometrics, Mc Graw hill.
4. Intrilligator, M.D (1980): Econometric Models, Techniques and Applications, Prentice Hall.

Subject Code	Subject Name	Credits Allotted		Total
APST-301	APPLIED ECONOMETRICS	Theory	Practical	4
		4	----	
Course Objective	1. To study about classical linear regression model and their estimation. 2. To discuss about Autocorrelation, different orders of Autocorrelation and their estimation procedures. 3. To explain different lag models and their estimate procedures. 4. To explain about simultaneous linear equations model and their different methods and estimation.			
Course Out comes	1. Students know about heteroscedasticity, multicollinearity and autocorrelation and their estimation procedures. 2. Students understood about different lag models and simultaneous linear equations model with their estimation methods.			

APST-302(A): Advanced Bio Statistics

Unit-I: Structure of Biological assay, Direct assays, Potency ratio, Feller's theorem and its generalization. Quantitative dose-response relationships, Linear dose-response regression, Parallel line bioassay, Slope Ratio Bioassay, Quantal responses, estimation of median effective dose, Transformations: Probit and Logit transformations.

Unit-II:: Basic Biological concepts: Gene, Chromosomes, Alleles, Concepts of Geno types and Phenotypes, Family studies, Basic mating from single gene cross, Matrix approach to basic matings of single gene cross, Checker board method, Mendal's law of heredity: Geneotypes and Pheno type ratios, Branching system method.

Unit-III:Types of matings, Random Mating, Concept of Gene pool, Gene frequency, Hardy–Weinberg law of equilibrium, Calculation of Gene frequencies, Genotypic frequency, Generation matrix approach to inbreeding, Estimation of Gene frequencies in ABO blood group system, Maximum Likelihood Method, Minimum Chi-Square method, Genetic parameters; Heritability Coefficients, Genetic Correlations, Repeatability, selection index; Inbreeding coefficient.

Unit-IV: Statistical Methods in Clinical Trials- phase I, II, III and IV trails. Statistical design for clinical trials- fixed sample trials. Simple randomized design, stratified randomized design, crossover and sequential designs – open and close sequential design. Dynamic randomization, Permuted block randomization; Single, double and triple blinding methods.

References

1. D.J. Finney (1971): Statistical Methods in Biological Assay, Charles Griffen and Company, London.

2. D.J. Finney (1971): Probit Analysis, 3rd Edition, S.Chand and Company Ltd, New Delhi.

3. William D. Stansfield. (1969): Theory and Problems of Genetics, Schaum’s Outline Series, MC Graw Hill, New York.

4. Oscar Kempthorne (1973): An Introduction to Genetic Statistics, Jagmohan Book agency, New Delhi.

5. J.P. Jain (1992): Statistical Techniques in Quantitative Genetics, 2nd Edition, Hindustan Publishing House, New Delhi.

6. Basu, S. B. (1996), Quantitative Genitics Research Technique, Kalyani Publishers, New Delhi.

7. Elisa T. Lee &John Wenyu Wang (2003): Statistical methods for Survival Data analysis, 3rd Edition, John Wiley

8. Jerrold H. Zar (1999): Biostatistical Analysis, 4th edition, Pearson.

9. Armitage, P, Berry G and Mathews J.N.S. (2002): Statistical Methods in Medical Research, 4/e, Blockwell Scientific Publications.

10. Rastogi. V.B. (2006), Fundamental of Biostatistics. ANE Books, India.

Subject Code	Subject Name	Credits Allotted		Total
APST 302(A)	ADVANCED BIOSTATISTICS	Theory	Practical	4
		4	----	
Course Objective	1. To discuss about Clinical trials and their statistical designs. 2. To know the Dose response relationships, their estimation, transformations. 3. To study Geno types and phenol types, Matrix operations to base mattings of single gen cross etc. 4. To estimate Gene frequency using different methods.			
Course Out comes	Students are familiar about Biological assay, their distribution and theorem, dose response relationships, basic concepts of biological assay, estimation methods of gene frequencies.			

APST-302(B): Theory of Point Estimation

Unit-I: Parametric models, likelihood function; examples from standard discrete and continuous models. Information in data. About the parameters as variation in likelihood function, concept of no information, sufficiency, Neyman factorizability criterion, likelihood equivalence. Fisher information for single and several parameters.

Unit-II: Minimal sufficient statistic, Exponential families and Pitman families. Minimum Variance Unbiased Estimation, unbiasedness, locally unbiased estimators, minimum variance, locally minimum variance, mean squared error, Cramer-Rao lower bound approach.

Unit-III:Minimum variance unbiased estimators(MVUE), Rao-Blackwell theorem, completeness, Lehman-Scheffe theorem, necessary and sufficient condition for MVUE.

Unit-IV:Consistent estimation of real and vector valued parameter, invariance of consistent estimator under continuous transformation: Consistency of estimators by method of moments and method of percentiles, mean squared error criterion, Asymptotic relative efficiency. Consistent asymptotic normal (CAN) estimator.

Course Outcome

- CO1: To apply various estimation and testing procedures to deal with real life problems.
- CO2: To understand Fisher Information, Lower bounds to variance of estimators, MVUE and apply them in practical situations.
- CO3: To understand consistency, sufficiency, unbiasedness, CAN and BAN estimators

References:

1. Casella G. and Berge R.L. (2002): Statistical Inference, 2nd Ed., Thomson- Duxbury, Singapore.
2. Kale B.K. and Muralidharan (2015): Parametric Inference, An Introduction, Alpha Science International Limited.
3. Kendall M.G. and Stuart A. (1968): The Advanced Theory of Statistics, Vol.II, Charles Griffin and Co.
4. Lehman E.L. (1986): Theory of Point Estimation, John Wiley.
5. Rao C.R. (1973): Linear Statistical Inference and Its Applications. Wiley Eastern.
6. Rohatgi V.K. and A.K.L. Salah (2001): An Introduction to Probability and Mathematical Statistics. Wiley Eastern.
7. Silvey S.D. (1970): Statistical Inference. Chapman and Hall.
8. Zacks S. (1981): Parametric Statistical Inference, Pergamon Press.

APST-303(A): Reliability and Survival Analysis

Unit-I: Reliability: Concept and Measures of Reliability, bath tub curve, Reliability and failure density in terms of hazard rate; Hazard models, System Reliability Models: Reliability of Series and parallel systems, Mixed configuration models, Non-series-parallel systems; r-out of n-systems, Fault tree analysis.

Unit-II: Reliability improvement methods: Redundancy, element, unit and stand by redundancies; Maintainability and availability; Reliability allocation; Life testing and Reliability estimation; Exponential failure model, Normal, Gamma and weibull distributions and their applications in reliability estimation.

Unit-III: Functions of Survival time: Definitions, Relationships of Survival Functions; Non-parametric Methods of Estimating Survival Functions: Kaplan Meier Product limit Estimate; Non-parametric methods for comparing two survival distributions: Gehan's generalized wilcoxon test, Cox-Mantel test, log rank test, Peto and peto's generalized wilcoxon test, Cox's F test and Mantel-Haenszel test.

Unit-IV: Graphical Methods for survival distributions fitting: Probability plotting, hazard plotting methods, testing of goodness of fit; Analytical Estimation Procedures for Survival distributions: Exponential, Weibull, Lognormal and Gamma Distributions only; Regression method for fitting Survival distributions; Parametric methods for comparing two survival distributions: Exponential, Weibull and Gamma Distributions only; Non-parametric and Parametric methods for identification of Prognostic factor relating survival time

References

1. L.S. Srinath (1998): Reliability Engineering, Applied East west Press PVT Ltd., New Delhi.
2. E. Balaguruswamy (1984): Reliability Engineering, Tata MC Graw Hill publishing company, New Delhi.
3. S.K. Sinha and B.K. Kale (1980): Life Testing and reliability Estimation, Wiley Eastern Ltd, New Delhi.
4. S.K. Sinha (1986): Reliability and Life Testing, Wiley Eastern Ltd, New Delhi.
5. Elisa T.Lee (1992), Statistical methods for survival data analysis, John Wiley sons.
6. Miller, R.G (1981), Survival Analysis, John Wiley
7. Cross A.J and Clark, V.A (1975), Survival distribution, reliability applications in the biomedical sciences, John Wiley and sons.
8. Elandt Johnson, R.E., Johnson, N.L.,(1999), Survival Models and Data Analysis, John Wiley and sons

Subject Code	Subject Name	Credits Allotted		Total
APST303(A)	RELIABILITY AND SURVIVAL ANALYSIS	Theory	Practical	4
		4	----	
Course Objective	1. To discuss about reliability and their measures, analysis mixed configuration, series and parallel systems with examples. 2. To explain Redundancy for unit, element and stand by with simple applications. 3. To discuss Distributions for life testing and reliability estimation with their applications. 4. To understand Survival functions, survival distributions and fittings.			
Course Out comes	Students learnt about and survival analysis with their related distributions, relationships, non-parametric methods for computing survival analysis.			

APST-303(B): Statistical Testing in Data Analysis

Unit-I: Population and sample, parameter, statistic, estimator, statistical properties of estimators. Basic concepts concerning testing of hypotheses, procedure for hypothesis testing. Null hypothesis, alternate hypothesis, statistical test procedures, test statistic, two types of errors, level of significance, p-value, size and power of the test. One sided and two sided test procedures. Parametric and nonparametric tests.

Unit-II: Assumptions, test procedures and examples - One sample Z test, hypothesis testing of means, hypothesis testing for differences between means under equal variance and unequal variances, paired t-test, tests for proportions. Sample size and its determination.

Unit-III: Hypothesis testing for comparing a variance to some hypothesized population variance, testing the equality of variances of two normal populations, hypothesis testing of correlation coefficients, confidence intervals.

Unit-IV: Non-parametric tests, sign test, Wilcoxon signed rank test, Wilcoxon rank sum test-Mann-Whitney test, Contingency tables - Chi-square test for independence of attributes, Principles of design of experiments, basic principle of ANOVA, ANOVA – CRD, RBD, LSD. Tukey multiple comparison test with equal sample sizes, Tukey-Kramer test with unequal sample sizes.

Course Outcomes:

CO1: Demonstrate their knowledge of the basics of inferential statistics by making valid generalizations from sample data

CO2: Perform Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases. Understand the concept of p-values.

CO3: Learn non-parametric test such as the Chi-Square test for Independence as well as Goodness of Fit.

CO4: Compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for forecasting and also perform ANOVA and F-test.

References:

1. J. Medhi (1992): Statistical Methods : An Introductory Text, Wiley Eastern Limited.
2. Douglas A. Lind, William C. Marchal, Samuel A. Wathen (2012), “Basic Statistics for Business & Economics” McGraw-Hill Education

APST-304: Practical – V (302 & 303)

APST-305(A): Applied Operations Research

Unit-I: Definition and scope of Operations research; phases in Operations Research; models and their solutions (Review of Linear Programming). Definition of Dual-Primal, Relationships- Dual Simplex Sensitivity or Post Optimal Analysis, Revised Simplex method.

Unit-II: Non-linear programming - Kuhn Tucker conditions. Wolfe's algorithm for solving quadratic programming problems. Integer programming – Branch and bound algorithm and cutting plane algorithm.

Unit-III: Flows in networks max-flow-min-cut theorem. Project Management; PERT and CPM probability of project completion, PERT – crashing. Decision making in the face of competition, two-person games, pure and mixed strategies, existence of solution and uniqueness of value in zero- sum games, finding solution in 2x2, and 2xm, and mxn games.

Unit-IV: Queuing models-specifications and effectiveness measures. Steady state solutions of M/M/1 and M/M/c models with associated distributions of queue length and waiting time. M/G/1 Queue and Pollaczek Khinchine result. Steady-state solutions of M/Ek/1 and Ek/M/1 queues. Bulk queues.

References

1. Taha H.A (1982) Operational Research: An Introduction; Macmillan.
2. Hiller F. Sand Leiberman G.J. (1962) Introduction to Operations Research; Holden Day
3. Kanti Swarup; Gupta P.K and Singh M.M (1985) Operations Research; Sultan Chand.
4. Philips D.T, Ravindran A and Solberg J Operations Research, Principles and Practice.
5. Curchman C.W; Ackoff R.L and Arnoff E.L(1957) introduction to Operations Research; John Wiley
6. Hadley G (1964) Non-Linear and Dynamic programming Addison Wesley.
7. Mckinsey J.C.C(1952) Introduction to the theory of games Mc Graw Hill.P.K.Gupta; D.S.Hira Operations Research S.CHand.

Subject Code	Subject Name	Credits Allotted		Total
APST-305(A)	APPLIED OPERATIONS RESEARCH	Theory	Practical	4
		4	----	
Course Objective	1. To explain different queuing models like M/M/I, M/M/C, M/G/I and bulk queues etc. 2. To learn about Non-linear programming and integer programming and their related problems. 3. To discuss about Network flow charts, CPM and PERT, project management models. 4. To study about Game theory of 2×2, $2 \times m$, $m \times n$ and non-zero sum games with their illustrations.			
Course Out comes	1. Students understood about Dual primal, Revised simplex methods. 2. Students gains the knowledge related to non-linear programming, integer programming, CPM, PERT and different models of games.			

APST-305(B): Computer Programming C++

UNIT-I: Object oriented programming principles, Declaration of classes, array of classes, Pointer to classes, constructors such as void constructor, copy constructor, Destructor,

UNIT-II: Friend functions, inline functions, static class members, this pointer, Single, Multiple inheritances: Types of derivation such as public, private, protected inheritance and member access controls, ambiguity in inheritance,

UNIT-III: Virtual base class, container classes. Function overloading, Operator Overloading, Overloading of assignment, binary, unary operators.

UNIT-IV: Polymorphism, Early binding, virtual functions, Late binding, pure virtual functions, abstract base classes, constructor under inheritance, destructor under inheritance, virtual destructors.Templates and Exception Handling. Data File operations, structures and file operations, classes and file operations.

References

1. R.Decker and So Hirshfield (1998): The Object Concept: An Introduction to Computer Programming using C++; PWS Publishing.
2. S.B.Lippmann and J.Lajoie (1998): C++ Primer. Third edition. Addison- Wesley. P.Nauhahton (1996).The Java Handbook. Tata McGraw-Hill
3. W.J. Savitch (2001): Problem Solving with C++The Object of Programming. Third Edition. Addison-Wesley Longman.
4. Deital&Deital: C++; Prentice-Hall Inc.
5. Sarang: Object Oriented programming with C++; Prentice-Hall Inc.
6. Balaguruswamy, E : Programming with C++; Tata McGraw-Hill.

Subject Code	Subject Name	Credits Allotted		Total
APST-305(B)	COMPUTER PROGRAMMING – C++	Theory	Practical	4
		4	----	
Course Objective	1. Understand principles of object-oriented programming, defining classes, Creating objects, initializing objects and destroying objects. 2. understand friend functions, inline functions, single and multiple inheritance, Different types of derivation and ambiguity in inheritance. 3. Understand virtual base class and container classes. Learn to overload functions and operators. 4. Understand polymorphism, virtual functions, pure virtual functions, constructors and destructors under inheritance. 5. Understand templates, exception handling, use of datafiles.			
Course Out comes	1: Understand principles of object-oriented programming, classes, different types of constructors and destructors. 2: Understand friend functions, different types of inheritance and their use. 3: Understand function over loading and operator over loading, overloading of unary and bi-nary operators. 4: Understand the definitions of abstract base classes, similarities and differences of virtual functions, and their use in polymorphism. 5: Understand the utility of function templates and class templates, exception handling mechanisms and use of datafiles.			

APST-306(A): LINEAR MODELS AND REGRESSION ANALYSIS

Unit-I: Two and Three variable Linear Regression models; General linear model: Assumptions; OLS estimation; BLUE; Tests of significance of individual regression coefficients; Testing the equality between two regressions coefficients; Test of significance of complete regression.

Unit-II: Criteria for model selection; Goodness of fit measures; R^2 and adjusted R^2 Criteria; C_p criterion; testing the general linear hypothesis; Chow test for Equality between sets of regression coefficients in two linear models; test for structural change; restricted least squares estimation; Generalized Mean Squared error criterion.

Unit-III: Non-normal disturbances and their consequences; test for normality; Jarque-Bera test; Shapiro-Wilk test, Minimum Absolute Deviation (MAD) estimation; Box-Cox transformations. Statistical analysis of residuals, OLS residuals, BLUS residual, Studentised residual, Predicted residual, tests against heteroscedasticity.

Unit-IV: Non-Linear regression; Non linear least squares estimation; Maximum Likelihood estimation; Idea of computational methods; Gradient methods, Steepest descent method and Newton-raphson method; testing general Nonlinear hypothesis; Wald test, Lagrange multiplier test and likelihood ratio Test. Robust , probit, binomial logistic ,multiple logistic regression.

References

1. Johnston, J (1984): Econometric Methods, III rd edition. MC Graw Hill.
2. Gujarathi, D (1979): Basic Econometrics, MC Graw Hill.
3. Judge, C.G., Griffiths, R.C.Hill, W.E ., Lutkephol, H and Lee, T.C (1985): The Theory and Practice of Econometrics, John Wiley and Sons.
4. Draper, N and Smith, B (1981): Applied Regression Analysis, Second Edition

Subject Code	Subject Name	Credits Allotted		Total
APST 306(A)	Linear models and Regression Analysis	Theory	Practical	4
		4	----	
Course Objective	1. To discuss about linear regression models and their assumptions. 2. To study about different criteria for model selection and their Goodness of fit measures. 3. To explain Non normal disturbances and their consequences and statistical analysis of residuals. 4. To discuss about Non-linear regression estimation methods.			
Course Out comes	1. Students learnt about different linear and non-linear regression models and their appropriate computational procedures. 2. They know R^2, adjusted R^2 and C_n criteria for model selection.			

APST-306(B): Total Quality Management and Six sigma

Unit I: Need for TQM, evolution of quality, Definition of quality, TQM philosophy – Contributions of Deming, Juran, Crosby, Taguchi and Ishikawa.

Unit II: Vision, Mission, Quality policy and objective, Planning and Organization for quality, Quality policy Deployment, Quality function deployment, Analysis of Quality Costs.

Unit III: Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

Unit IV : SIX SIGMA AND PDSA: An overview of six sigma methodology, DMAIC, DFSS and lean six sigma; product / process understanding : SIPOC, VSM, FMEA ; The Seven QC Tools of Quality, New Seven management tools, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

Reference

1. Narayana V. and Sreenivasan, N.S.(1996): “Quality Management – Concepts and Tasks”, New Age International.
2. Zeiri(1991): “Total Quality Management for Engineers”, Wood Head Publishers.
3. Juran J.M and Frank M.Gryna Jr.(1982): “Quality Planning and Analysis”, TMH, India.
4. Brain Rethery(1993): ISO 9000, Productivity and Quality Publishing Pvt.Ltd.
5. D. Mills(1993): Quality Auditing, Chapman and Hall.

APST-307: Practical – VI (305 and 306)

APST-308:OOTC

SEMESTER- IV								
S.no	Course	Code	Tittle of the course	H/W	C	SEE	IA	TOTAL Marks
01	OOSDC	APST 401	A:Advanced Econometric Methods B:Python	4	3	50	25	75
02	PW	APST 402	A: Statistics For Research, Industry And Community development B:Agricultural Statistics	4	3	50	25	75
03		APST 403	Practical – VII (401 and 402)	6	2	35	15	50
			Conducting Classes for Competitive, Communications Skill UGC/CSIR and NET/SLET examinations	12	--	--	--	--
			Total	36	20	200	100	300
			Total Semester	144	84	1220	580	1800

APST-401(A): Advanced Econometric Methods

Unit-I: Generalized linear Model; Aitken’s theorem; GLS estimator, Asymptotic distribution of GLS estimator; Analysis of residuals, OLS, BLUEs and Recursive residuals; Studentized and predicted residuals; Granger’s test of causality; nested and non nested statistical models; Cox and J tests.

Unit-II: Specification error; Consequences; specification bias; Ramsey’s RESET test; Lagrange Multiplier test for adding variables; comparing two linear regression models; Dummy variable approach; Stepwise and Piecewise linear regression; Switching Regression Model.

Unit-III: Qualitative and limited dependent variable models; the linear probability model; probit model; Logit model and their estimation; concept of limited dependent variables; specification of Tobit model; concepts of censored and Truncated samples; estimation in censored and Truncated Samples.

Unit-IV: Sets of linear regression models; specification of the Seemingly Unrelated Regression Equations (SURE) model; OLS and GLS estimation of SURE model; Zellner’s Feasible GLS estimator; Seemingly Unrelated Unrestricted Residuals (SUUR) estimator; Seemingly Unrelated Restricted Residuals (SURR) estimator; Reduction of the Zellner’s Feasible GLS estimator to the OLS estimator.

References

1. Johnston, J (1984): Econometric Methods, III rd edition , MC Graw Hill.

2. Judge, C.G., Griffiths, and Hill, R.C. et al (1985): Theory and Practice of Econometrics, John Wiley.

3. Gujarathi, D (1979): Basic Econometrics, Mc Graw hill.

4. Srivastava, V.K and Giles, D.E.A (1987), Seemingly Unrelated Regression Equations Models: Estimation and Inference, Marcel Dekker, Inc

5. Cook. D and Weisberg. S (1982), Residuals and Inference in Regression, Chapman and Hall.

Subject Code	Subject Name	Credits Allotted		Total
APST401(A)	Advanced Econometric Methods	Theory	Practical	4
		4	----	
Course Objective	1. To explain OLS, GLS, BLUE and Recursive residuals with their properties. 2. To discuss different regression models and their importance. 3. To perform estimation in censored and Truncated Samples. 4. To fit sets of linear regression models and their related estimators.			
Course Out comes	1. Students understood GLM, SURE, nested and non nested statistical models. 2. Students learnt about specification error, adding, switching models. 3. Students performed Probit, logit models and their estimation.			

APST-401(B): Python

UNIT – I:Introduction to Python Programming Language:

Introduction to Python Language,Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections, In Functions.

UNIT –II :Object and Classes : Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes.

UNIT –III : Functions and Modules : Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules, Standard Modules – sys,□Standard Modules – math,Standard Modules – time,The dir Function.

UNIT –IV : I/O and Error Handling In Python : Introduction, Data Streams,□Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data From a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions.

Books for Study:

1. Dive into Python, Mike

2. Learning Python, 4th Edition by Mark Lutz

3. Programming Python, 4th Edition by Mark Lutz

Course Outcomes:

- 1: Able to understand the concept of Python Programming.
- 2: Expertise in Object and Classes.
- 3: To be able to explore Functions and Modules learning.
- 4: Able to understand the concept of I/O and Error Handling In Python.

APST-402(A): STATISTICS FOR RESEARCH, INDUSTRY AND COMMUNITY DEVELOPMENT

UNIT- I: Response Surface Designs: First and Second order Response Surface models; Rotatable designs; concept of connected design; outliers and Winsorized t - statistic; Stepwise regression; Specification of Random coefficients Regression model; Specification of variance components model; MINQUE Theory; Non parametric regression, the partially linear regression model.

UNIT-II: Simulation: Scope and limitations; Simulation models; Generation of RandomNumbers; Monte-Carlo simulation; Simulation of Queueing, Inventory Systems; Networks and Job sequencing.Data Envelopment Analysis (DEA): Non parametric approach to productive efficiency; Input, output correspondences for Frontier production function; Mathematical Programming for productive efficiency: Farrell and Timmer approaches with reference to Cobb-Douglas production function.

UNIT-III: Demand Analysis: Laws of Demand and Supply; price and partial elasticities of demand; Pigous method for Time Series and Family Budget data; Engel's curve; Pareto law of Income distribution;Production Functions: Basic concepts; Isoquants; Cobb-Douglas, CES and Translog Production functions and their properties and estimation; Tools for Data Mining.

UNIT-IV: Social Surveys for Community Development: Objects, Types of Social Survey; Steps in social survey; Gallop polls; Prephology, Data collection; Kinds of measurement; Scaling methods: Thurstone, Likert and Guttman methods; Concepts of Validity and Reliability; Methods of calculating reliability coefficients; Test Reliability; ANOVA for Ranked data: Kruskal-Wallis and Friedman tests; Elements of cluster analysis, Factor analysis., path coefficient analysis and Discriminant analysis.

References

1. Das, M.N. and Giri, N.C. (1979), Design and Analysis for Experiments, Wiley Eastern (P) Ltd., New Delhi.
2. Montgomery, C.D. (1976), Design and Analysis of Experiments, Wiley & Sons, New York.
3. Johnston, J., and Dinardo, J. (1997), Econometric Methods, Fourth Edition, Mc Graw-Hill International Editions, New York.
4. Judge., C.G., et.al (1985), Theory and Practice of Econometrics, John Wiley.
Taha, H.A. (1992), Operations Research, An Introduction, Fourth Edition

APST-402(B): Agricultural Statistics

UNIT-I: History of Agricultural Development in India. Current Production Utilization and Growth Trends of Agricultural Commodities In India. Crop Improvement: Plant Breeding Traditional and Contemporary Methods, Plant Classification, Description and Economic Use of Field Crops. Biotechnological Tools for Crop Improvement, Plant Genetics Resources, Seed Quality Control, Seed Production Methods, Seed Sowing Methods, Seed Stages. Crop Production: Modern Approaches of Management of Pest and Disease, Principles of Plant Pathology.

UNIT-II: Plant Science: Metabolic Processes and Growth Regulation, Climate Change, Reproduction, Post Harvest Physiology, Soil Environment Microbiology, Bio-Fertilizer. Useful Organism: Honey Bees and Bee Keeping, Lack Insect and Silk Worm. Horticulture: Fundamental of Horticulture, Orchards Management, Breeding of Horticultural Crops, Improvement of Fruit and Plantation Crops. Importance of Fruits and Vegetables In Human Nutrition. Contribution of Horticulture In National Economy and Export.

UNIT-III: Some Basic Genetical Terms, Statistical Analysis of Segregation, Detection and Estimation of Linkage. Gene and Genotypic Frequencies. Random Mating and Equilibrium In Large Populations. Disequilibrium Due To Linkages for Two Pairs of Genes and for Sex Linked Genes. Selection, Mutation and Migration. Equilibrium Between forces In Large Population. Polymorphism. Fisher's Fundamental Theorem of Natural Selection.

UNIT-IV: Polygenic Systems for Quantitative Characters, Concepts of Breeding Value, Dominance, Average Effect of Gene and Epistatic Interactions. Genetic Variance and Its Partitioning. Correlation Between Relatives. Regular System of Inbreeding, Effects of Inbreeding. Genotype and Environment Interaction, Stability Parameters.

Books suggested:-

1. Falconer, D.S. : Introduction to quantitative Genetics (Longman Group Ltd.)
- Kempthorne, O (1953) : An Introduction to Genetical Statistics, Wiley Eastern
2. Prem Narain : Statistical Genetics, Wiley Eastern ICAR : Handbook of Agriculture, ICAR Publication.
3. Jain, J.P. : Statistical Technique in Quantitative Genetics (Tata Mc Graw, Hill Publication Co. Ltd., New Delhi.

APST-403: Practical – VII (APST-401 and APST-402)

APST-404: student project

65 Marks for project thesis, 25 for project Viva Voce and 10 marks for Project presentation.
