ANNAMALAI UNIVERSITY

402 - M.Sc. Statistics

Programme Structure and Scheme of Examination (under CBCS)
(Applicable to the candidates of affiliated colleges admitted from the academic year 2022-2023 onwards)

Course Code	Study Components & Course Title	Hours/Week	Credit	Maximum Marks		
				CIA	ESE	Total
	SEMESTER – I					
22PSTAC11	Core Course-I : Matrices and Linear Algebra	6	4	25	75	100
22PSTAC12	Core Course-II : Measure and Probability Theory	6	4	25	75	100
22PSTAC13	Core Course-III : Sampling Theory	5	4	25	75	100
22PSTAP14	Core Practical-I : Statistics Practical-I	6	3	40	60	100
22PSTAE15	Core Elective – I	4	4	25	75	100
22PSTAO16	Open Elective – I	3	3	25	75	100
	Total	**30**	**22**			**600**
	SEMESTER – II					
22PSTAC21	Core Course-IV : Distribution Theory	6	4	25	75	100
22PSTAC22	Core Course-V : Estimation Theory	6	4	25	75	100
22PSTAC23	Core Course-VI : Statistical Quality Control and Reliability	6	4	25	75	100
22PSTAP24	Core Practical-II : Statistics Practical-II	6	3	40	60	100
22PSTAE25	Core Elective – II	4	4	25	75	100
22PHUMR27	**Compulsory Course: Human Rights**	2	2	25	75	100
	Total	**30**	**21**			**600**

List of Core Electives (Choose any one out of three given in each Semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	Total
I	22PSTAE15-1	Operations Research	4	4	25	75	100
	22PSTAE15-2	Official Statistics	4	4	25	75	100
	22PSTAE15-3	Python Programming	4	4	25	75	100
II	22PSTAE25-1	Programming in C++ with Application	4	4	25	75	100
	22PSTAE25-2	Data Mining	4	4	25	75	100
	22PSTAE25-3	Demography	4	4	25	75	100

List of Open Electives (Choose any one out of three given in each Semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	Total
I	22PSTAO16-1	Statistical Methods	3	3	25	75	100
	22PSTAO16-2	Descriptive Statistics	3	3	25	75	100
	22PSTAO16-3	Basic Bio Statistics	3	3	25	75	100

SEMESTER: I PART: Core Course-I	22PSTAC11: MATRICES AND LINEAR ALGEBRA	CREDIT: 4 HOURS: 6

COURSE OBJECTIVES

1. To enrich the skills of students for learning the concepts, methods of matrices and linear algebra.
2. To learn some advanced concept of linear transformations of vector spaces.
3. To learn eigenvalues and eigenvectors and the Characteristic equation of a matrix.

UNIT I: MATRIX ALGEBRA AND DETERMINANTS Hours: 16

Definition and operations on matrices - Symmetric, Hermitian and Triangular matrices. Powers and trace of a square matrix. Determinants-Permutation and Inversion, Co-factor and minor , Properties and Evaluation of Determinants.

[Contents and treatments as in chapters 1, 2 and 3 of text book-1]

UNIT II: RANK AND EQUIVALENCE OF MATRICES Hours: 16

Rank of a Matrix, Elementary transformations of a matrix, Invariance of a rank through elementary transformations, Theorems on elementary transformations, Reduction to normal form, Elementary matrices, The rank of a product, A convenient method for computing the inverse of a non-singular matrix by elementary row transformations, Equivalence matrices.

[Contents and treatments as in chapters 3 and 4 of text book-1].

UNIT III: VECTOR SPACE AND SYSTEM OF LINEAR EQUATIONS Hours: 16

Introduction, Ordered set of numbers, Vector space, Linear dependent and Linearly Independent set of vectors, Sub spaces of an n-vector space V_n, Invariant character of the number of vectors in a basis, Row and column spaces of a matrix, Equality of row rank and column rank, Ranks of symmetric matrices. Linear transformation of a vector- System of linear homogeneous equations, Null space and Nullity of a matrix, Sylvester's law of nullity, Range of a matrix, System of homogeneous equations.

[Contents and treatments as in chapters 5 and 6 of text book-1].

UNIT IV: QUADRATIC FORMS AND CONGRUENCE OF MATRICES Hours: 16

Quadratic forms, Quadratic form a product of matrices, Linear transformations, The set of Quadratic forms over F, Congruence of quadratic forms and matrices, Congruent transformations of a symmetric matrices, Elementary congruent matrices, Congruent reduction of a symmetric matrices , Congruence of skew-symmetric matrices.

[Contents and treatments as in chapters 7 and 8 of text book-1].

UNIT V: CHARACTERISTIC ROOTS AND CHARACTERISTIC VECTORS OF A MATRIX Hours: 16

Characteristic roots and characteristic vectors of a square matrix, Some fundamental theorems, Nature of the characteristic roots of some special types of matrices, Relation between algebraic and geometric multiplicities of a characteristic root, Mutual relationship between characteristic vectors corresponding to different characteristic roots, The construction of orthogonal matrices, Construction of unitary matrices.

[Contents and treatments as in chapter 11of text book-1].

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. Solving problems in matrices and quadratic forms.
2. Understand various matrix transformations.
3. Understand the concepts of vector space.
4. Solving problems in quadratic forms.
5. Obtain nature of the characteristic roots and orthogonal matrix.

TEXT BOOKS

1. Shanti Narayan. (2018). *A Text Book of Matrices*, Sultan Chand & Co, New Delhi.
2. Datta, K.B. (2000). *Matrix and Linear Algebra.* Prentice-Hall of India Pvt. Ltd., New Delhi.

SUPPLEMENTARY READINGS

1. Herstein, I.N., & David J. Winter. (1988). *Matrix Theory and Linear Algebra*. Macmillan, London.
2. Hohn, F.E. (1973). *Elementary Matrix Algebra*. Macmillan, London.
3. Horn, R.A., & Johnson, C.R. (1985). *Matrix Analysis*. Cambridge University Press, London.
4. Johnson, L.W., & R.D. Riess. (1981). *Introduction to Linear Algebra.* Addison-Wesley. Reading (Mass).

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	3	2	3	2	3
CO3	3	3	3	2	3
CO4	3	2	3	3	3
CO5	2	2	3	2	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: I PART: Core Course-II	22PSTAC12: MEASURE AND PROBABILITY THEORY	CREDIT: 4 HOURS: 6

COURSE OBJECTIVES

To introduce students to measure theory in a rigorous way and explore some applications to probability theory.

UNIT I: **Hours: 16**

Limit Superior, Limit inferior and limit of a sequence of sets - Field and Sigma fields, Borel field, Monotone class. Functions and inverse functions- Countable and Finitely Additive Set Function - Measurable space - Measure space - Measure, Properties of Measure. Lebesgue – Steiltjes measure – Lebesgue measure. Measurable function, Simple function. Concept of almost everywhere. Approximation theorem (statement only).

UNIT II: **Hours: 16**

Measure Integral – Properties – Monotone convergence theorem – Fatou's lemma – Dominated convergence theorem (statement only) – Absolute continuity of two measures. Product sets and Fubini's theorem (statement only).

UNIT III: **Hours: 16**

Random Variables – Limit of Random Variables - Probability Space – Definition – Properties – Discrete, General and Induced Probability Spaces - Distribution Functions – Decomposition of Distribution Functions – Distribution Functions of Vector of Random Variables – Correspondence Theorem - Expectation and Moments – Properties – Inequalities.

UNIT IV: **Hours: 16**

Convergence of random variables – Convergence in Probability, Almost surely, Distribution, r^{th} Mean – Convergence Theorem for Expectations – Characteristic function – Definition and Properties - Inversion formula Characteristic Function and Moments - Convergence of Distribution Functions – Weak Convergence.

UNIT V: **Hours: 16**

Independence – Properties – Zero-One Laws – Law of Large Numbers - Kolmogorov's Strong Law of Large Numbers, Central Limit Theorems – De Moivre's - Lindeberg-Levy and Liapounov's Central Limit Theorems.

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. Understand the various types of measures.
2. Study the theorems relating to measures.
3. Apply the concepts of random variables.
4. Have depth knowledge in Convergence of random variables.
5. Utilize the law of large numbers in research studies.

TEXT BOOKS

1. Bhat, B.R. (2019). *Modern Probability Theory* (Revised 4^{th} ed.). New Age International Publisher, New Delhi.
2. Burill, C.W (1972). *Measure, Integration and Probability*, McGraw Hill, New York.

SUPPLEMENTARY READINGS

1. Ash, R.B.(1972). *Real Analysis and Probability.* Academic Press, New York.
2. Billingsley, P.(2012).*Probability and Measure*(3rd ed.). Wiley, New York.
3. Feller, W.(2008). *An Introduction to Probability Theory and Its Applications.* Vol.I, (3rd ed.). Wiley, New York.
4. Loe've, M. (1955). *Probability Theory.* D. Van Nostrand, London.
5. Munroe, M.E. (1965). *Measure and Integration.* Addison & Wesley, New York.
6. Tucker, H.G. (1967). *A Graduate Course in Probability.* Academic Press, New York.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	3
CO2	3	3	3	2	2
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: I PART: Core Course-III	22PSTAC13: SAMPLING THEORY	CREDIT: 4 HOURS : 5

COURSE OBJECTIVES

To enrich the skills of students to get more specialization in various sampling procedures and for adopting the appropriate sampling technique in real life application and survey.

UNIT I: BASICS AND SIMPLE RANDOM SAMPLING (SRS) Hours: 16

Introduction – Concepts and Definitions – Parameter and Statistic – Census Versus Sampling – Principles – Principal Steps – Sample Design – Types – Errors-Sampling and Non Sampling Errors- Simple Random Sampling-Procedures of Selecting a Random Sample-Estimation of Population Parameters-Estimation of Population Proportion-Combination of Unbiased Estimators-Confidence Limits-Estimation of Sample Size.

[Contents and Treatments as in Chapters 1 and 2 of text book-1]

UNIT II: STRATIFIED RANDOM SAMPLING Hours: 16

Introduction – Notations – Principles and Advantages of Stratification-Estimator of Population Mean and Variance – Estimate of Variance-Allocation of Sample in Different Strata – Comparison under Different Allocations – Estimation of Gain in Precision due to Stratification – Determination of Optimum Number of Strata – Method of Collapsed Strata-Post Stratification- Deep Stratification - Controlled selection.

[Contents and Treatments as in Chapter 3 of text book-1]

UNIT III: SYSTEMATIC RANDOM SAMPLING Hours: 16

Sample Selection Procedures - Advantages and Disadvantages -Estimation of Mean and its Sampling Variance – Comparison with SRS and Stratified Sampling – Estimation of Variance-Interpenetrating Systematic Sampling - Linear and Circular Systematic Sampling – Two Dimensional Systematic Sampling.

[Contents and Treatments as in Chapter 4 of text book-1]

UNIT IV: VARYING PROBABILITY SAMPLING Hours: 16

Introduction-Procedures of Selecting a Sample-Estimation in Probability Proportional to Size(PPs) Sampling with Replacement- Gain Due to PPs Sampling with Replacement- Procedures of Selection of a PPs Sample without Replacement-Ordered Estimators -Des Raj's Ordered Estimator- Unordered Estimators- Horvitz-Thompson Estimator-Murthy's Unordered Estimator.

[Contents and Treatments as in Chapter 5 of text book-1]

UNIT V: CLUSTER AND TWO-STAGE SAMPLING Hours: 16

Cluster Sampling – Introduction – Equal Clusters – Estimator of Population Mean and Variance – Relative Efficiency of Cluster Sampling-Optimum Cluster Size-Cluster Sampling for Proportions-Relative Efficiency of Unequal Cluster Sampling-Varying Probability Cluster Sampling-Two Stage Sampling – Advantages – Equal First Stage Units – Unequal First Stage Units – Estimator.

[Contents and Treatments as in Chapters 8and 9 of text book-1]

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. Gain the knowledge on applications of various sampling techniques applied to sample surveys.
2. Learn the concept of stratified random sampling and its associated results.
3. Apply Linear and circular systematic sampling methods in real life data
4. Understand different probability sampling schemes, ordered and unordered estimator.
5. Understand cluster and two stage sampling with its advantages in various fields.

TEXT BOOK

Daroga Singh & Chaudhary, F.S. (1986). *Theory and Analysis of sample survey design.* New Age International Publishers, New Delhi.

SUPPLEMENTARY READINGS

1. Agarwal, N.P& Sonia Agarwal. (2006). *Sampling methods and Hypothesis testing*. RBSA Publishers.
2. Archana Bansal. (2017). *Survey Sampling* (3rd ed.). Narosa Publishing House Pvt. Ltd., New Delhi.
3. Cochran, W. (1984). *Sampling Techniques*. Wily Eastern, New York.
4. Desraj & Promod Chandhok. (1998). *Sample survey theory*. Narosa Publishing House Pvt. Ltd. New Delhi.
5. Murthy, M.N. (1977). *Sampling Theory and Methods.* Statistical Publishing Society, Kolkatta.
6. Parimal Mukhopadhyay. (1998). *Theory and Methods of survey sampling*. Prentice Hall of India Pvt. Ltd.
7. Sampath, S. (2005). *Sampling theory and Methods.* Narosa Publishing House Pvt. Ltd. New Delhi.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	2	3	3	3	3
CO3	3	3	3	3	3
CO4	3	2	3	2	3
CO5	3	3	2	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: I PART: Core Practical-I	22PSTAP14: STATISTICS PRACTICAL-I (Using SPSS)	CREDIT: 3 HOURS : 6

Course Objectives

To Gain the knowledge of basic statistical computation using SPSS.

PRACTICAL SCHEDULE

SPSS

- ✧ Descriptive Statistics.
- ✧ Correlation and Regression (Simple and Multiple).
- ✧ Test for Single mean.
- ✧ Test for difference of mean.
- ✧ Paired t-Test.
- ✧ Chi-Square Test.
- ✧ Hotelling's T-Square Test
- ✧ Principal Component Analysis.
- ✧ Factor Analysis.
- ✧ Discriminant Function.
- ✧ Cluster Analysis.
- ✧ Completely Randomized Design
- ✧ Randomized Block Design
- ✧ Latin Square Design
- ✧ Kruskal Wallis H-Test
- ✧ Wald-Wolfowitz Run Test
- ✧ Wilcoxon Signed Rank Test
- ✧ Median Test

Course Outcomes

At the end of the course, the student will be able to:

1. Familiarize in drawing diagrams and graphs using SPSS.
2. Calculate the various statistical measures.
3. Test the significance of the parameters.
4. Apply ANOVA test for appropriate data.
5. Analyze the data using various multivariate analyses.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	2	2
CO3	2	3	3	3	3
CO4	2	3	2	3	3
CO5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: I PART: Core Elective-I	22PSTAE15-1: OPERATIONS RESEARCH	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

To build strong theoretical foundation of various optimization techniques in operations research that makes use of statistical concepts abundantly.

Unit I: **LINEAR PROGRAMMING PROBLEM (LPP)** **Hours: 11**

Properties of LPP – formulation of LPP - Simplex method – Two-phase method and Big M Method - Duality in LPP - Dual Simplex method.

UNIT II: **TRANSPORTATION PROBLEM** **Hours: 11**

Mathematical formulation, Basic Feasible Solution (BFS) - Loops in a transportation problem and their properties – Methods of BFS and test of optimality - Transportation Algorithm - Degeneracy in transportation problem - Unbalanced transportation problem - Assignment Problem – Introduction and Mathematical Formulation - Hungarian Method - Unbalanced Assignment Problem.

UNIT III: **GAME THEORY** **Hours: 11**

Two-person zero-sum games – Maximin - Minimax Criterion - Minimax and Saddle Point Theorem – Dominance Principle - Connection between Game problem and LPP - Solution of (mXn) games - Algebraic method and Matrix method - Iterative method for approximate solution.

Unit IV: **PROJECT MANAGEMENT BY PERT AND CPM** **Hours: 11**

Definition of PERT and CPM - Basic steps involved in PERT and CPM techniques - Network diagram representation - Fulkerson's rule of drawing a network diagram - Determination of critical path, project duration and crashing of project duration – PERT- time estimates and related results, Optimum Project Duration and Minimum Project Cost.

UNIT V: **INVENTORY MODELS** **Hours: 11**

Structure of Inventory Control Models, Functional Role of Inventory, Factors Involved in Inventory Problem Analysis, General deterministic problem for Single item, Single Item Inventory Control models with and without shortage, Multi Item Inventory Models with Constraints problem.

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Understand application of Statistical and Mathematical concepts in Operations Research.
2. Identify suitable method for solving optimization problems.
3. Solve game theory problems in real life situation.
4. Apply project management techniques practically.
5. Solve the economic problems using inventory models.

TEXT BOOKS

1. Kanti Swarup, Gupta, P.K., & Man Mohan (2007). *Operations Research.* Sultan Chand & Sons, New Delhi.

SUPPLEMENTARY READINGS

1. Hadley,G. (1963). *Linear Programming*. AddisonWesley.
2. Hillier,F.S.& Lieberman,G.J.(2005). *Introduction to Operations*(9th ed.) Mc Graw Hill, New York.
3. Kambo, N.S. (1991). *Mathematical Programming techniques*. Affiliated East-west Press Pvt Ltd.
4. Prem Kumar Gupta & Hira, D.S. (2010).*Problems in Operations Research*. Sultan Chand & Co. Limited, New Delhi.
5. Rao, S.S. (2004). *Engineering Optimization.* New Age International (P) Ltd, New Delhi.
6. Sharma, J.K.(2013). *Operation Research: Problems and Solutions* (5th ed.). Macmillan India, New Delhi.
7. Sharma,S.D.(2010).*Operations Research*. Kedarnath Ramnath, Meerut.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	2	3	3
CO4	2	3	2	3	3
CO5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH3					

SEMESTER: I PART: Core Elective-I	22PSTAE15-2: OFFICIAL STATISTICS	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

1. Understand the functioning of government and its policies.
2. Promote human resource development in the official statistics and encourage research and development in theoretical and applied statistics.
3. Execute the data handling tasks in various government records.

UNIT I: STATISTICAL SYSTEM **Hours: 11**

Introduction to National and International Official Statistical Systems – Role & responsibilities, function and activities of Central and State statistical organizations - Organization of large scales sample surveys - Role of National Statistical Office (NSO) - General and special data dissemination systems.

UNIT II: **Hours: 11**

National Statistical Commission – Need, constitution, its role, functions etc., Important Acts for Official Statistics, Population Census – Need - Data Collected – Periodicity – Methods of data collection – dissemination – agencies involved.

UNIT III: AGRICULTURAL AND SOCIAL STATISTICS **Hours: 11**

System of collection of Agricultural Statistics - Crop forecasting and estimation -Productivity, fragmentation of holdings - Support prices - Buffer stocks, Sector-wise Statistics – Trade – Industries – Service – Balance of Payment – Inflation – Social Statistics, etc.

UNIT IV: INDEX NUMBERS **Hours: 11**

Index Numbers: Price, Quantity and Value indices. Price Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Chain base Index Number. Consumer Price Index, Wholesale Price Index and Index of Industrial Production – Construction of index numbers and uses.

UNIT V: NATIONAL INCOME **Hours: 11**

National Income – Methods of estimating National Income - Income, expenditure and production methods. Measurement of income inequality: Gini's coefficient, Engel curves, Pareto and Lognormal as income distribution.

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Understand the key aspects of official statistics
2. Evaluate the methods for data collection, analysis and interpretation of health, social and economic.
3. Know the legal and ethical constraints on organizations producing official statistics.
4. Understand the methods for presenting and preparing commentaries on official statistics.
5. Overcome the limitations that arises from measurement and processes of statistical production.

TEXT BOOKS

1. Mukhopadhyay, P.(2011). *Applied Statistics*, 2nd Edition, Books & Allied Ltd.
2. *India Guide to Official Statistics* (CSO) 1999.
3. C.S.O (1990) *Basic Statistics Relating to Indian Economy.*
4. Official Website of Ministry of Statistics & Programme Implementation www.mospi.gov.in

SUPPLEMENTARY READINGS

1. Family Welfare Yearbook. Annual Publication of D/o Family Welfare. Guide to Official Statistics (CSO), 1999.
2. Monthly Statistics of Foreign Trade in India, DGCIS, Calcutta and other Govt. Publications.
3. Goon A.M., Gupta, M.K., & Das Gupta, B. (2001), Fundamentals of Statistics, Vol. 2, World Press, India.
4. Pane, V.G.*Estimation of Crop Yields* (FAO).
5. Principles and accommodation of National Population Censuses, UNESCO.
6. Statistical System in India (CSO) 1995.

RELATED ONLINE CONTENTS

https://www.mospi.gov.in/documents/213904/0/Ch+14+30.8.2001.pdf/d944ae06-bc59-ff09-9502-39d897b2ed0b?t=1599817175203
https://www.mospi.gov.in/national-statistical-commission-nsc

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	2
CO5	3	3	3	3	2
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: I PART: Core Elective-I	22PSTAE15-3: PYTHON PROGRAMMING	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

To enable the students to learn basic python skills and data structures.

UNIT I: PYTHON BASICS **Hours:11**

Introduction to Python: Features of Python - How to Run Python – Identifiers - Reserved Keywords - Variables - Comments in Python - Indentation in Python - Multi-Line Statements - Multiple Statement Group (Suite) – Quotes in Python - Input, Output and Import Functions - Operators. Data Types and Operations: Numbers-Strings-List-Tuple-Set-Dictionary-Data type conversion.

UNIT II: CONTROL AND FUNCTIONS **Hours:11**

Flow Control: Decision Making-Loops-Nested Loops-Types of Loops. Functions: Function Definition-Function Calling - Function Arguments - Recursive Functions - Function with more than one return value. **Data handling and Strings:** Reading data - Working with strings – exception handling – NumPy Basics: Arrays and Vectorized Computation.

UNIT III: PACKAGE AND FILE HANDLING **Hours:11**

Import Statement - Packages in Python - Date and Time Modules File Handling: Opening a File - Closing a File - Writing to a File – Reading from a File - File Methods - Renaming a File - Deleting a File - Directories in Python.

Unit IV: DATA ANALYSIS **Hours:11**

Using Pandas, the python and data analysis library – Series and data frames – Data Aggregation and Group Operations – Merging and joining. **Visualization:** Visualization with matplotlib – figures and subplots – Plotting Functions in pandas - Labeling and arranging figures – Outputting graphics.

UNIT V: TIME SERIES ANALYSIS **Hours:11**

Time Series Analysis: Date and Time Data Types and Tools - Time Series Basics - Periods and Period Arithmetic - ARIMA Forecasts - Time Series Plotting - Simple Linear Regression Models.

COURSE OUTCOMES

At the end of the course, the student will be able to

1. Understand the basics of python and data structures.
2. Apply suitable built-in data structures to solve the problem.
3. Understand various methods in file handling.
4. Understand the use of pandas.
5. Design and program python applications.

TEXT BOOKS

1. Jake Vander Plas (2016).*Python Data Science Handbook: Essential Tools for Working with Data* (1st ed.). O'Reilly Media, Inc., USA.
2. Jeeva Jose & Sojan Lal, P. (2016). *Introduction to Computing and Problem Solving with Python*. Khanna Book Publising Co. (P) Ltd.
3. WesMcKinney (2013). *Python for Data Analysis* (2nd ed.). O'Reilly Media, Inc., USA.

SUPPLEMENTARY READINGS

1. Guttag, J.V. (2016). *Introduction to computation and programming using Python*. (2nd ed.). MIT Press.
2. Kamthane, A. N., & Kamthane, A.A. (2017). *Programming and Problem Solving with Python*. McGraw Hill Education.
3. Kulkarni (2017). *Problem Solving and Python Programming* (1st ed.). Yes Dee Publishing Pvt Ltd.
4. Liang, Y. D. (2013). *Introduction to Programming using Python*. Pearson Education.
5. Taneja, S.& Kumar, N. (2018). *Python Programming- A modular Approach*. Pearson Education India.

RELATED ONLINE CONTENTS [MOOC, SWAYAM, NPTEL, WEBSITES ETC.]

1. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-cs26/
2. https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-cs21/

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	3
CO2	3	3	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Course-IV	22PSTAC21: DISTRIBUTION THEORY	CREDIT : 4 HOURS : 6

COURSE OBJECTIVES

To know the basic ideas of continuous and truncated distributions and to study the concepts of bivariate distribution, non-central t, F and Chi square and Beta distributions, Order statistics and quadratic forms.

Unit I: PROBABILITY DISTRIBUTIONS **Hours: 16**

Detailed Study of Binomial, Poisson, Normal, Exponential, Gamma, Beta and Cauchy distributions (derivations, properties, moments, characteristic function and applications) - Concept of truncated distributions and Compound distribution.

Unit II: BIVARIATE DISTRIBUTION **Hours: 16**

Bivariate distribution- Concept of joint, marginal and conditional distribution; Functions of random variables and their distributions- maximum and minimum, sum, difference, product and quotient of random variables; Various techniques of finding distributions of functions of random variables; Distribution functions involving several random variables.

Unit III: NON-CENTRAL PROBABILITY DISTRIBUTIONS **Hours: 16**

Non-Central t, F and Chi square distribution - Properties of these distributions - Sampling distributions of mean, correlation and regression coefficients for normal samples (null case).

Unit IV: ORDER STATISTICS **Hours: 16**

Cumulative distribution function of a single order statistics, p.d.f of a single order statistics, joint p.d.f of two order statistics, joint p.d.f of k^{th} order statistics, joint p.d.f of all 'n' order statistics- Distribution of range, mid range and quantiles.

Unit V: QUADRATIC FORMS IN NORMAL RANDOM VARIABLES **Hours: 16**

Quadratic forms for normal variables, Distribution of quadratic forms, Conditions for independence of quadratic forms and linear forms- Cochran's theorem (Without proof).

COURSE OUTCOMES

At the end of the course, the students will be able to:

1. Study the various discrete and continuous distributions.
2. Study the various truncated distributions.
3. Understand the bivariate distributions.
4. Study the distributions of order statistics.
5. Understand the distributions of quadratic forms in normal random variable.

TEXT BOOKS

1. Bhuyan, K.C. (2015). *Probability Distribution Theory and Statistical Inference.* New Central Book Agency, London.
2. Gupta, S.C. & Kapoor, V.K. (2014). *Fundamentals of Mathematical Statistics.* Sultan Chand & Sons, New Delhi.
3. Searle, S.R. (2014). *Linear Models*. Wiley, New York.

SUPPLEMENTARY READINGS

1. Johnson, N.L., Kemp, A.W., & Kotz, S. (2005). *Univariate Discrete Distributions.* (2nd ed.). Wiley, New York.
2. Johnson, N.L., Kotz, S.,& Balakrishnan, N. (2004). *Continuous Univariate Distributions*, Vol. I. Wiley , Singapore.
3. Johnson, N.L., Kotz, S., & Balakrishnan, N. (2014). *Continuous Univariate Distributions.* Vol. II.Wiley, Singapore.
4. Mood A.M., Graybill, F.A., & Boes, D.C. (1974). *Introduction to the theory of Statistics* (3rd ed.). McGraw Hill Publishing Co. Inc., New York.
5. Parimal Mukhopadhyay. (1996). *Mathematical Statistics*. New Central Book Agency, Pvt. Ltd. Calcutta.
6. Rao, C.R. (2009). *Linear Statistical Inference and Its Applications* (2nd ed.). Wiley, New York.
7. Rohatgi, V.K., & Saleh, A.K., Md. E. (2011). *An Introduction to Probability and Statistics*. Wiley, New Delhi.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	2
CO2	2	3	3	3	3
CO3	3	3	3	3	3
CO4	2	2	2	2	2
CO5	3	3	2	3	2
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Course-V	22PSTAC22: ESTIMATION THEORY	CREDIT: 4 HOURS : 6

COURSE OBJECTIVES

To enhance the methods of diagnosis of statistical estimation of parameters.

UNIT I: UNBIASEDNESS AND CONSISTENCY **Hours: 16**

Point Estimation, Highest Concentration Criterion, Minimum MSE Criterion, Unbiased Estimators, Quenoulli's Method(jackknife technique) of Reducing the Bias in Stages, Consistent Estimator, BAN Estimator and Case of Several Parameters.
[Contents as in Chapter 2 of text book]

Unit II: SUFFICIENCY AND COMPLETENESS **Hours: 16**

Sufficient Statistics, Fisher Information Measure, Neyman-Fisher Factorization Theorem, Minimal Sufficient Statistics, Complete Statistics, Exponential Family of Distributions, Pitman's Family of Distributions.
[Contents as in Chapter 3 of text book]

Unit III: MINIMUM VARIANCE UNBIASED ESTIMATORS **Hours: 16**

Case of a single parameter, Lower Bounds for Variance of Unbiased Estimators (Cramer-Rao Inequality) UMVUE, Bhattacharya Inequality, Chapman-Robin's Inequality, Rao-Blackwell theorem, Lehmann- Scheffe Theorem. Use of Sufficient and Complete Statistics.
[Contents as in Chapter 4 of text book]

Unit IV: METHOD OF ESTIMATION **Hours: 16**

Method of moments, method of maximum likelihood, Fisher's Iteration Technique of MLE, Properties of MLE, Method of Minimum Chi-square and Its Modification, Method of Least Squares.
[Contents as in Chapter 5 of text book]

Unit V: INTERVAL ESTIMATION **Hours: 16**

A general Method of Constructing Confidence Intervals (CIs), Construction of Shortest Average Width CIs, Construction of CIs in Large Samples, Construction of Most Accurate CIs, Construction of Bayesian CIs..
[Contents as in Chapter 6 of text book]

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Study the various criteria of estimators.
2. Understand the concepts of sufficiency and completeness.
3. Derive different inequalities.
4. Understand the various methods of estimation and interval estimation.
5. Study the Baye's estimation.

TEXT BOOK

Rajagopalan, M & Dhanavanthan. P. (2012), *Statistical inference*, PHI Learning Private Limited, New Delhi.

SUPPLEMENTARY READINGS

1. Gibbons, J.D., & Chakraborti, S. (2010). *Nonparametric Statistical Inference*(3rded.). Marcel Dekker.
2. Lehman, E.L.,& Casella, G. (1998). *Theory of Point Estimation* (2nd ed.). Springer - Verlag.
3. Manoj Kumar Srivastava, Abdul Hamid Khan & Namita Srivatsava (2014). *Statistical Inference – Theory of Estimation.* PHI Learning Private Limited, Delhi.
4. Rao, C.R. (1973).*Linear Statistical Inference and Its Applications*. (2nded.). Wiley, New York.
5. Santhakumaran, A. (2004). *Probability Models and Their Parametric Estimation*. K.P.Jam Publication, Chennai.
6. Zack, S. (1981). *Parametric Statistical Inference: Basic Theory and Modern Approach*. Pergamon Press.
7. Zacks, S. (1971). *The Theory of Statistical inference*. John Wiley, New York.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	2	3	2
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Course-VI	22PSTAC23: STATISTICAL QUALITY CONTROL AND RELIABILITY	CREDIT: 4 HOURS : 6

COURSE OBJECTIVES

To enhance the knowledge of statistical applications in industries.

UNIT I: STATISTICAL QUALITY CONTROL (SQC) AND CONTROL CHARTS Hours: 16

Meaning and scope of SQC - Causes of Quality variation - Statistical Basis for Control Charts - Choice of Control Limits - Sample size and Sampling Frequency - Rational subgroups – Specification - Tolerance and Warning Limits - Construction and operations of X bar, R and σ charts - np, p, c and u Charts.

[Contents as in Chapters 4 and 5 of text book-1]

UNIT II: CUMULATIVE SUM (CUSUM) CONTROL CHARTS Hours: 16

CUSUM control chart - Basic Principles and Design of CUSUM charts - Concept of V-mask - One- and Two-Sided Decision Procedures – Moving Average and Geometric Moving Average Control Chart - Sloping Control Charts.

[Contents as in Chapter 7 of text book-1]

UNIT III: ACCEPTANCE SAMPLING PLANS Hours: 16

Acceptance Sampling Plans - Rectifying Inspection - Sampling Inspection by Attributes, Concept of OC, ASN, ATI, AOQ functions of sampling plans - AQL, LTPD, Producer's Risk and Consumer's Risk on OC curve - Operation and Use of Single, Double and Multiple Sampling Plans.

[Contents as in Chapter 13 of text book-1]

UNIT IV: CONTINUOUS SAMPLING PLANS Hours: 16

Sampling Inspection by Variables - known and unknown sigma, Variable sampling plan, merits and demerits of variable sampling plan, derivation of OC curve. Determination of parameters of the plan. Continuous Sampling Plans (CSP) by attributes, CSP-1, CSP -2 and CSP-3. Concept of AOQL in CSPs - Indian Standards ISO 2000 (concepts only).

[Contents as in Chapter 14 of text book-1]

UNIT V: RELIABILITY Hours: 16

Concept of Reliability - Components and Systems, Coherent Systems Reliability of Coherent Systems - Life distributions Reliability Function - Hazard rate - Standard Life Time Distribution - Exponential, Weibull, Gamma distributions - Reliability of System with Independent Components - Basic Idea of Maintainability.

[Contents as in relevant Chapter of text book-2]

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Draw and obtaining results of various control charts.
2. Study the Cusum, V-mask and moving average control charts.
3. Understand the concepts of acceptance sampling plans and their functions.
4. Apply the various sampling inspections in real life situations.
5. Understand the various concepts of reliability and their applications.

TEXT BOOKS

1. Douglas C. Montgomery. (2005). *Introduction to Statistical Quality Control* (3rd ed.). John Wiley & Sons, New York.
2. Duncan A.J. (1959). *Quality control and Industrial Management.* (Richard D. Irwin Inc.USA).

SUPPLEMENTARY READINGS

1. Bain, L., & Engelhardt, M. (1991). *Statistical Analysis of Reliability and Life Testing Models*. Marcel-Dekker, New York, NY, USA.
2. Biswas, S. (1996). *Statistics of Quality control, Sampling Inspection and Reliability*. New AgeIndia International.
3. Burr, I.W. (1953). *Engineering Statistics and Quality Control.* McGraw Hill.
4. Leaven worth, R.S. (1964). *Statistical Quality Control.* Mc Graw Hill.
5. Mahajan, M. (1998). *Statistical Quality Control*. Dhanpat Rao & Co, New Delhi.
6. Schilling, E.G. (1982). *Advances in acceptance sampling*. ASQC Publications, New York.
7. Sinha, S.K. (1979). *Reliability and Life-Testing*. Wiley Eastern, New Delhi.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	3	3	3
CO3	2	2	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	2
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Practical-II	22PSTAP24: STATISTICS PRACTICAL-II (Calculator Based)	CREDIT: 3 HOURS : 6

COURSE OBJECTIVES

To have practical knowledge on application of matrices to linear problems, sampling technique, estimate the parameter and statistical quality control using real life data.

PRACTICAL SCHEDULE

Matrix and Linear Algebra

- ✧ Operations on Matrices
- ✧ Evaluation of Determinants
- ✧ Solution of Linear Simultaneous Equations
- ✧ Cramer's Rule
- ✧ Sweep-out Methods
- ✧ Inverse of a Matrix
- ✧ Rank of Matrix
- ✧ Eigen values and Eigenvectors

Sampling

- ✧ Estimation of Sample Mean and Sample Variance under SRSWOR
- ✧ Estimation of Sample Mean and Sample Variance under SRSWR
- ✧ Estimation of Proportion under SRSWOR.
- ✧ Estimation of Population total, Mean and Variances under Systematic Sampling.
- ✧ Estimation of Mean, Variances under Stratified Random Sampling.

Estimation

- ✧ Unbiased Estimator
- ✧ Maximum Likelihood Estimation method
- ✧ Method of Least Squares
- ✧ Confidence Intervals

STATISTICAL QUALITY CONTROL

Control Chart:

- ✧ Average and Range Chart
- ✧ Average and Standard Deviation Chart
- ✧ **Np** Chart
- ✧ **P** Chart
- ✧ **C** Chart
- ✧ **U** Chart

Single Sampling Plan:

- ✧ OC, ASN, ATI and AOQ Curves

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Solving problems in matrix algebra.
2. Find the rank of a matrix.
3. Solve problems of sampling plans.
4. Calculate problems relating to estimation methods.
5. Construct the charts and graphs in SQC.

OUTCOME MAPPING

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Elective-II	22PSTAE25-1: PROGRAMMING IN C++ WITH APPLICATION	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

This course aims to introducing the language C++ in a systematic manner to make the students to have knowledge in program writing and developing the software.

UNIT I: INTRODUCTION TO OOPS AND C++ Hours:11

Object Oriented System: Difference Between Procedural and Object Oriented Languages, Object Oriented Paradigm, Inheritance, Polymorphism, Abstraction, Encapsulation, Benefits and Application of Oops. **Introduction to C++:** Character Set, Token, Constants, Variables and Data Types, Enumeration Types, Operators, Expressions, Operator Precedence and Associatively, Input, Output, Conditional Statements, Scope of Variables, Type Conversion.

UNIT II: CONTROL STATEMENTS Hours: 11

Conditional expression, Switch statement, loop statements, Breaking control statements; Functions and Program structures; Introduction, definition, Types of functions, Actual and Formal arguments, Default augments, Storage class specifies, Recursive function, Pre-processors, Header files and standard function.

UNIT III: ARRAYS, POINTERS AND FUNCTION Hours: 11

Array: Notation, Declaration, Initialization, Processing, Arrays and Functions, Multidimensional arrays. **Pointers**: Declaration, Arithmetic; Pointers and Functions, Pointers and Arrays; Strings, Array of Pointers, Pointers to Pointers. **Function:** Functions - Standard and User-Defined Function, Recursive Function, Passing By Value And Reference, Function Overloading.

UNIT IV: STRUCTURES AND CLASS Hours: 11

Structure: Declaration, Initialization, Functions, Array of structures, Arrays within a structure, Nested Structures, Pointers and Structures, Unions and Bit fields, Enumerations. **Class:** Introduction to Class and Object, Declaring Members and Methods in a class, declaring objects.

UNIT V: OOPS CONCEPTS Hours: 11

Functions and objects, Inline Function, Friend Functions and Its Usage, Abstract Class, Function Overriding. Constructor and Destructor- Needs and Its Usage, Types of Constructors, Destructor, Static Data Members and Methods. Inheritance - Need of Inheritance, Types of Inheritance and its implementation.

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Understand the fundamental concepts of C++ programming.
2. Understand the various statements of C++.
3. Study the arrays and pointers in C++.
4. Familiarize in structures, classes and objects of C ++.
5. Write programs and find results using C++.

Text Books

1. Ravichandran, D. (2003). *Programming with C++* (2nd ed.). Tata Mc Graw Hill Publications, Company Ltd.
2. Balagurusamy, E. (2006). *Programming with C++* (3rd ed.). Tata Mc Graw Hill Publications, Company Ltd.

Supplementary Readings

1. Eric Nagler. (1999). *Learning C++* (2nd ed.). PWS Publishing Co., Ltd.
2. Robert Lafore. (2002). *Object Oriented Programming in C++* (4th ed.). Galgotia Publications Pvt. Ltd. New Delhi.
3. Venugopal, K. R., Rajkumar, B. & Ravi Shankar, T. (1999). *Mastering C++*. Tata McGraw Hill, New Delhi.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	3
CO2	3	3	3	3	3
CO3	3	3	2	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Elective-II	22PSTAE25-2: DATA MINING	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

Enable students to gain knowledge about basic concepts of data warehousing and data mining and to understand the various techniques involved in mining the data from the databases.

UNIT I : DATA MINING BASICS **Hours: 11**

What is Data Mining– Kinds of Data – Kinds of patterns – Technologies used for Data Mining– Major Issues in Data Mining– Data –Data Objects and Attribute types– Data Visualization– Measuring Data Similarity and Dissimilarity–Data Preprocessing– overview– Data Cleaning– Data Integration– Data Reduction– Data Transformation and Data Discretization.

UNIT II : DATA WAREHOUSING AND OLAP **Hours: 11**

Data Warehouse– Basic concepts–Data Warehouse Modeling: Data Cube and OLAP– Data Warehouse Design and Usage– Data Warehouse Implementation– Data Generalization by Attribute–Oriented Induction– Data Cube Technology– Data Cube Computation Methods– Exploring Cube Technology–Multidimensional Data Analysis in cube space.

UNIT III: PATTERNS AND CLASSIFICATION **Hours: 11**

Patterns– Basic concepts– Pattern Evaluation Methods–Pattern Mining: Pattern Mining in Multilevel– Multidimensional space–Constraint–Based Frequent Pattern Mining– Mining High Dimensional Data and Colossal patterns– Mining compressed or Approximate patterns– Pattern Exploration and Application. Classification–Decision tree Induction– Baye's Classification methods– Rule based Classification– Model Evaluation and selection– Techniques to Improve Classification Accuracy– Other Classification methods.

UNIT IV: CLUSTERING AND OUTLIER DETECTION **Hours: 11**

Cluster Analysis– Partitioning Methods–Hierarchical Methods–Density–Based Methods– Grid–Based Methods – Evaluation of Clustering.– Clustering High – Dimensional Data–Clustering Graph and Network Data – Clustering with Constraints–Web Mining– Spatial Mining. Outlier Detection – Outliers and Outliers Analysis–Outlier Detection Methods–Outlier Approaches–Statistical–Proximity–Based– Clustering–Based– Classification Based – High–Dimensional Data.

UNIT V: DATA MINING ALGORITHMS **Hours: 11**

Hierarchical algorithm – Single Link- MST Single Link -Complete Link - Average Link- Dendrogram - Partitional Algorithm – MST -Squared Error - K-Means - Nearest Neighbor – PAM – BEA – GA - Categorical algorithm-Large Database.

COURSE OUTCOMES

At the end of the course, the student will be able to:

1. Learn the concept of data base technology which has led to the need for data mining and its applications.
2. Examine the types of data to be mined and present a general classification of task to integrate data mining system.
3. Identify patterns and relationships to predict future trends.
4. Evaluate and select appropriate data mining algorithms and apply, interpret and report the output appropriately.
5. Understand the concept of web mining.

Text Books

1. Berry, J.A. & Linoff, G.S. (2011). *Data Mining Techniques* (3rd ed.). Wiley, New York.
2. Chattamvelli, R. (2009). *Data mining Methods*. Alpha Science International, Oxford.
3. Jiawei Han & Micheline Kamber. (2006). *Data Mining Concepts and Techniques*. Morgan Kaufman Publishers, Massachusetts.

Supplementary Readings

1. Brieman, L. Friedman, J.H., Olshen, R.A., & Stone, C.J.(1984). *Classification and regression trees*, Wadsworth & Brooks, California.
2. Dunham, M.H. (2006). *Data mining: Introductory and Advanced Topics*. Pearson, New Delhi.
3. Gorunescu, F. (2010). *Data mining Concepts, Models and Techniques*. Springer, NewYork.
4. Hand, D. Mannila, H. & Smyth, P. (2001). *Principles of Data mining.* MIT Press, Cambridge.
5. Larose, D.T. (2005).*Discovering Knowledge in Data: An Introduction to Data Mining*. Wiley, Toronto.
6. Pujari, A.K. (2001). *Data Mining Techniques*. Universities Press, Hyderabad.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	2	3	3	3	2
CO3	3	3	2	3	3
CO4	3	3	3	2	3
CO5	3	3	2	2	2
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					

SEMESTER: II PART: Core Elective-II	22PSTAE25-3: DEMOGRAPHY	CREDIT: 4 HOURS : 4

COURSE OBJECTIVES

To enable the students to understand the basic concepts of demographic analysis.

UNIT I : DEMOGRAPHIC DATA **Hours: 11**

Development and scope of demography – Demographic data: sources and current status-Chandrashekar-Deming index-Adjustment of age data –use of Whipple- Myer and UN indices - Population size and growth in India- Trends and differentials in world population – Health Surveys and use of hospital statistics – Population transition theory.

UNIT II : MEASUREMENTS OF MORTALITY **Hours: 11**

Mortality - Basic measurements - Crude, specific, standardized death rates -Life table - construction, use and interpretation - force of mortality – abridged life tables.

UNIT III: MEASURE OF FERTILITY **Hours: 11**

Fertility -Basic measurements - Gross and Net Reproduction rate - Cohort fertilityanalysis-Fertilitymodels-PopulationregulationprogramsinIndia-Demographictransitiontheory.

UNIT IV: POPULATION MIGRATION **Hours: 11**

Special distribution of population-basic concepts- measurements and models of migration- concept of international migration – Urban development components of urban and metropolitan growth-Urbanization in developed and developing countries-Stable and quasi populations-Intrinsic growth rate.

UNIT V: COMPONENTS OF POPULATION GROWTH AND CHANGE **Hours: 11**

Components of population growth and change – Models of population growth and their filling to population data – Methods of projection- Logistic equation -component method of projection - stable population theory – Decennial population census in India–Nuptiality and its measurements.

COURSE OUTCOMES

1. Understand the concepts and learn the basics of birth, death and other vital statistics.
2. Provide the basic knowledge in measurements of population and obtain the
3. various measures.
4. Analyse the fertility models and demographic transition theory.
5. Population density and distribution.
6. Use the logistic model to predict and interpret unknown results.

Text Books

1. Gupta, S. C., & Kapoor, V. K. (2016). *Fundamentals of Applied Statistics*. Sultan Chand & Sons Private Limited, New Delhi.
2. Gun, A.M., Gupta. M.K.,& Das Gupta. B. (2016).*Fundamental of Statistics*. Vol.2, World Press Private Ltd, Kolkata.
3. Mukhopadhyay, P. (2011).*Applied Statistics*(2nd ed.). Books and Allied (P) Ltd. India.

Supplementary Readings

1. Benjamin, B. (1975).*Demographic Analysis*. George Allen and Unwin, London.
2. Cox, D.R.(1978). *Demography*. Cambridge University Press, Cambridge.
3. Gibbs, J.P.(2012). *Urban Research Methods*. Literary Licensing. LLC, White Fish,USA.
4. Keyfliz, N. & Caswell, H.(2006). *Applied Mathematical Demography*. Springer, New York.
5. Kumar,R. (1986). *Technical Demography*. Wiley Eastern, New Delhi.
6. Misra, B.D. (1982). *An Introduction to the Study of Population*. South East Asia Publishers, Madras.
7. Spiegelman, M.(1969). *Introduction to Demographic Analysis*. Harvard University Press, Harward.
8. Wolfenden, H.H. (1954). *Population Statistics and their Compilation*. University of Chicago Press, Chicago.

OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	3	3	3	3	2
CO3	3	2	2	2	2
CO4	3	3	3	3	3
Co5	3	3	3	3	3
CORRELATION LEVEL: 1-LOW, 2-MEDIUM, 3-HIGH					