STS322J: Mathematical Statistics   **CREDITS: 4+2**

Course Objectives:
Mathematical Statistics serves as a building block that will enable students to learn more advanced techniques that will help them to solve problems more quickly and easily.

Course Outcomes:
After completing this course, a student will have:
- Ability to understand concept of Concept of multiple correlation, Partial correlation with their applications.
- Ability to understand the concept of Concept of multiple regression and partial regression with their applications.
- Ability to deal with problems of attributes.
- Ability to understand the concept of Curve Fitting.

THEORY: 04 CREDITS

UNIT I

Multiple and Partial Correlation: Concept of multiple correlation, Partial correlation and its Importance, assumptions and applications. Yules notation, residual, primary and secondary subscripts, Properties of residuals without proof, Coefficient of multiple correlation and partial correlation. Multiple correlation in terms of total and partial correlation. Important properties of multiple correlation coefficient (without proof).

UNIT II
Curve Fitting: Concept, dependent and independent variable, Types of curves, Method of least square for fitting straight line, fitting of parabola, Fitting of exponential curve $y = ab^x$. Fitting of Power curve of the form $y = ax^b$ and related examples. Free-hand method of curve fitting.

UNIT III
Multiple Regression: Concept of multiple regression its Importance, applications and assumptions, Formulation of the multiple regression model, Interpretation of regression coefficients, Multiple correlation coefficient (R) and coefficient of determination (R-squared), Adjusted R-squared and its interpretation, Introduction to nonlinear regression models

UNIT IV
Analysis of Categorical Data: Level of Measurements, Notations, Classes and class frequencies, order of classes, Relation between class frequencies, Consistency of categorical data, Independence of attributes, Association of attributes, Yule's coefficient of association, Coefficient of colligation.

PRACTICAL: 02 CREDITS   (PREFERABLY THROUGH COMPUTERS)

List of Practical's:

  I.   Practical Problems based on Concept of multiple correlation.
 II.   Practical Problems based on Partial correlation.
III.   Practical Problems based on multiple regression
 IV.   Practical Problems based on partial regression .
  V.   Fitting of 1st degree line to the data set.
 VI.   Fitting 2nd degree parabola to the data set.
VII.   Predicting value of dependent variable in case of straight line and second degree parabola for data set.

BOOKS RECOMMENDED:

1. Hogg, R. V., McKean, J. and Craig, A. T. (2012). Introduction to Mathematical Statistics.
2. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
3. Das N,G. Statistical Methods Vol I, McGraw Hill Education India.
4. S.P Gupta. Statistical Methods, Sultan Chand and Sons.
5. Kapur, J.N. and Saxena, H.C. (1976). Mathematical Statistics, Sultan Chand and sons.
6. Mood, A.M. Graybill, F.A. and Boes, D.C. (1974). Introduction to the Theory of Statistics, 3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.
7. Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
8. Prasad, G. (1997). Differential Calculus, 14th Ed., Pothishala Pvt. Ltd., Allahabad.
9. Prasad, G. (2000). Integral Calculus, 14th Ed., Pothishala Pvt. Ltd., Allahabad.
10. Ahsan, Z. (2004). Differential Equations and their Applications, 2nd Ed., Prentice- Hall of India Pvt. Ltd., New Delhi

STS322N: Mathematical Statistics   **CREDITS: 4+2**

Course Objectives:
Mathematical Statistics serves as a building block that will enable students to learn more advanced techniques that will help them to solve problems more quickly and easily.

Course Outcomes:
After completing this course, a student will have:
- Ability to understand concept of Concept of multiple correlation, Partial correlation with their applications.
- Ability to understand the concept of Concept of multiple regression and partial regression with their applications.
- Ability to deal with problems of attributes.
- Ability to understand the concept of Curve Fitting.

THEORY: 04 CREDITS

UNIT I

Multiple and Partial correlation: Concept of multiple correlation, Partial correlation and its Importance, assumptions and applications. Yules notation, residual, primary and secondary subscripts, Properties of residuals without proof, Coefficient of multiple correlation and partial correlation. Multiple correlation in terms of total and partial correlation. Important properties of multiple correlation coefficient (without proof).

UNIT II

Curve Fitting: Concept, dependent and independent variable, Types of curves, Method of least square for fitting straight line, fitting of parabola, Fitting of exponential curve $y = ab^x$. Fitting of Power curve of the form $y = ax^b$ and related examples. Free-hand method of curve fitting.

UNIT III

Multiple Regression: Concept of multiple regression its Importance, applications and assumptions, Formulation of the multiple regression model, Interpretation of regression coefficients, Multiple correlation coefficient (R) and coefficient of determination (R-squared), Adjusted R-squared and its interpretation, Introduction to nonlinear regression models

UNIT IV
Analysis of Categorical Data: Level of Measurements, Notations, Classes and class frequencies, order of classes, Relation between class frequencies, Consistency of categorical data, Independence of attributes, Association of attributes, Yule's coefficient of association, Coefficient of colligation.

PRACTICAL: 02 CREDITS   (PREFERABLY THROUGH COMPUTERS)

List of Practical's:

  I.   Practical Problems based on Concept of multiple correlation.
 II.   Practical Problems based on Partial correlation.
III.   Practical Problems based on multiple regression
 IV.   Practical Problems based on partial regression .
  V.   Fitting of 1st degree line to the data set.
 VI.   Fitting 2nd degree parabola to the data set.
VII.   Predicting value of dependent variable in case of straight line and second degree parabola
         for data set.

BOOKS RECOMMENDED:

  1. Hogg, R. V., McKean, J. and Craig, A. T. (2012). Introduction to Mathematical Statistics.
  2. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.),
     Sultan Chand and Sons.
  3. Das N,G. Statistical Methods Vol I, McGraw Hill Education India.
  4. S.P Gupta. Statistical Methods, Sultan Chand and Sons.
  5. Kapur, J.N. and Saxena, H.C. (1976). Mathematical Statistics, Sultan Chand and sons.
  6. Mood, A.M. Graybill, F.A. and Boes, D.C. (1974). Introduction to the Theory of Statistics,
     3rd Edn., Tata McGraw-Hill Pub. Co. Ltd.
  7. Rohatgi, V.K. and Saleh, A.E. (2008). An introduction to Probability Theory and
     Mathematical Statistics, Wiley Eastern.
  8. Prasad, G. (1997). Differential Calculus, 14th Ed., Pothishala Pvt. Ltd., Allahabad.
  9. Prasad, G. (2000). Integral Calculus, 14th Ed., Pothishala Pvt. Ltd., Allahabad.
 10. Ahsan, Z. (2004). Differential Equations and their Applications, 2nd Ed., Prentice- Hall of
     India Pvt. Ltd., New Delhi

STS422J1: TESTING OF HYPOTHESIS   **Credits: 3+1**

Course Objectives:

The learning objectives include:
- To understand the concept of sampling distributions and their applications in statistical inference.
- To understand the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Course Learning Outcomes:

After completing this course, students should have developed a clear understanding of:
- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Hypothesis testing based on a single sample and two samples using both classical and pvalue approach.

THEORY: 03 CREDITS

UNIT I

Concept of population, sample, Statistic, parameter and sampling distribution. Standard error of sample means and sample proportion. Statistical hypothesis and its types. One tail and two tail tests. Types of errors, level of significance and critical region, P Value, Procedure for testing of hypothesis.

UNIT II

Estimation and Estimate, Point Estimation and Interval Estimation, confidence Interval.
Large sample tests: Tests of significance and confidence Interval for testing of a single mean, single proportion, difference of two means and two proportions.

UNIT III

Exact sampling distributions: t- Statistics. Test for single mean and difference between two means. Paired t-test for difference between two means. F- Statistics or Variance Ratio Test. Assumptions in F-test. Tests of hypothesis of the variance of two populations.
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PRACTICAL: 01 CREDIT   **(PREFERABLY THROUGH COMPUTERS)**

List of Practical's:

I. Large Sample Tests : Testing of significance and confidence intervals for single proportion and differenceof two proportions.
II. Testing of significance and confidence intervals for single mean and difference oftwo means. .
III. Small sample tests: Testing of significance and confidence intervals for single mean and difference oftwo means and paired t – test.
IV. Testing and confidence intervals of equality of two population variances.

BOOKS RECOMMENDED:

1. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
2. Das N,G. Statistical Methods Vol I, McGraw Hill Education India.
3. S.P Gupta. Statistical Methods, Sultan Chand and Sons.
4. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). *An Outline of Statistical Theory*,Vol. I, 4th Ed., World Press, Kolkata.
5. Hogg, R.V. and Tanis, E.A. (2009). *A Brief Course in Mathematical Statistics*. PearsonEducation.
6. Johnson, R.A. and Bhattacharya, G.K. (2001). *Statistics-Principles and Methods*, 4thEd., John Wiley and Sons.
7. Mood, M.A., Graybill, F.A. and Boes, C.D. (2007). *Introduction to the Theory of Statistics*, 3rd Ed., (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
8. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). *An Introduction to Probability and Statistics*, 2nd Ed., (Reprint) John Wiley

SEMESTER 4th
MAJOR COURSE (Major Type 2)

STS422J2: APPLIED STATISTICS   **CREDITS: 4+2**

Course Objectives:
The learning objectives include:
- This course will help students to know the applications of Statistics and learn and applythese techniques in the core course of their study.
- This course will give exposure to four applied fields of statistics viz. Time Series, IndexNumbers
- They will be having hands on practice of working on the data related to above mentioned fields

Course Learning Outcomes:
After completing this course, students should have developed an understanding of:
- Time series data, components of time series data, study the behavior and identifying thevariation due to different components in the data.
- They will study to identify and measure various components of time series data.
- The fundamental concepts of Index Numbers, Construction of price and quantity Indexnumbers.
- Construction of Wholesale and Consumer price Index and its significance.

THEORY: 04 CREDITS

UNIT I
Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Estimation of trend by free hand curve method, method of semi averages, fitting mathematical curve and growth curves. Estimation of trend by method of moving averages. Detrending: effect of elimination of trend on other components of a time series.

UNIT II
Seasonal Component: Estimation of seasonal component by the methods of - simple averages, Ratio to Trend, Ratio to Moving Averages and Link Relative method. Deseasonalization. Cyclic Component: Harmonic Analysis.

UNIT III
Economic statistics: Index number, its definition and applications. Criteria for good index numbers, Problems involved in computation of index number, Construction of wholesale price index number, fixed base index number and Consumer price index number with interpretation. Uses and limitations of index numbers.

UNIT IV
Price relatives and quantity or volume relatives, link and chain relatives, Uses of averages, simple aggregative and Weighted average methods, Lasperey's, Passche's , Marshall-Edgeworth's and Fisher's index numbers, time and factor reversal tests of index number.

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PRACTICAL: 02 CREDITS   (PREFERABLY THROUGH COMPUTERS)

List of Practical's:
I. Fitting of trend by Moving Average Method for given extent and for estimated extent.
II. Measurement of Seasonal indices:
   a. Simple Averages method
   b. Ratio-to-Trend method
   c. Ratio-to-Moving Average method
   d. Link Relative method
III. Construction of index number by Laspeyre's, Passche's and Fisher's method.
IV. Computation of reversal tests.

BOOKS RECOMMENDED:

1. Kendall, M.G. (1976). Time Series, 2nd Ed., Charles Griffin and Co Ltd., London and High Wycombe.
2. Chatfield, C. (1980). The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay, P. (2011). *Applied Statistics*, 2nd Ed., Revised reprint, Books and Allied
4. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2003). *Fundamentals of Statistics*, 6thEd., Vol II Revised,Enlarged.
5. Gupta, S.C. and Kapoor, V.K. (2014). *Fundamentals of Applied Statistics*, 11th Ed., Sultan Chand and Sons.
6. Montgomery, D. C. and Johnson, L. A. (1967). *Forecasting and Time Series Analysis*,1st Ed. McGraw-Hill, New York.

STS422J3: VITAL STATISTICS   **Credits: 4+2**

Course Objectives:
The learning objectives include:
- To collect valid Demographic data using different methods.
- To learn basic of Role of Ministry of Statistics & Program Implementation
- To learn basic of measures of Mortality, Fertility and Population Growth.

Course Learning Outcomes:
After completing this course, students should have developed a clear understanding of:
- Methods of collection of official statistics Control chars for variables and Attributes
- Distinction between Vital Statistics and Demography.
- Basic measures of Mortality.
- Basic measures of Fertility.

THEORY: 04 CREDITS

UNIT I
Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

UNIT II
Introduction and definition of vital Statistics, Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events.Coverage and content errors in demographic data, use of balancing equations, Chandrasekharan-Deming formula to check completeness of registration data. Dependency ratio. Accuracy of age data on sex and age: Whipple's and Myer's indices

UNIT III
Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates. Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life(Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

UNIT IV

Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR), Relation between CBR, GFR and TFR. Dandekars Binomial and Poisson Models, William Brass Model.

PRACTICAL: 02 CREDITS   (PREFERABLY THROUGH COMPUTERS)

List of Practical's:

I.   To calculate CDR and Age Specific death rate for a given set of data.
II.   To find standardized death rate by: (i) Direct method (ii) Indirect method.
III.   To construct a complete life table.
IV.   To calculate CBR, GFR, SFR, TFR for a given set of data.
V.   To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data.
VI.   Calculate GRR and NRR for a given set of data and compare them.

BOOKS RECOMMENDED:
1. Biswas, S. (1988). *Stochastic Processes in Demography & Application*, Wiley EasternLtd.
2. Croxton, Fredrick, E. Cowden, Dudley J. and Klein, S. (1973). *Applied General Statistics*, 3rd Ed., Prentice Hall of India Pvt. Ltd.
3. Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008). *Fundamentals of Statistics*, Vol. II,9thEd., World Press.
4. Keyfitz, N. and Beekman,J.A. (1985). *Demography through Problems*. S-Verlag, NewYork.
5. Mukhopadhyay, P. (1999). *Applied Statistics*, Books and Allied (P) Ltd.
6. Gupta and Mukhopadhay P.P: Applied Statistics, Central Book Agency
7. Cowden D.J (1960): Statistics Methods in Quality Control, Asia Publishing Society

SEMESTER 4th
MINOR COURSE

STS422N: TESTING OF HYPOTHESIS   **Credits: 3+1**

Course Objectives:
The learning objectives include:
- To understand the concept of sampling distributions and their applications in statistical inference.
- To understand the process of hypothesis testing.
- To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Course Learning Outcomes:
After completing this course, students should have developed a clear understanding of:
- Basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
- Hypothesis testing based on a single sample and two samples using both classical and pvalue approach.

THEORY: 03 CREDITS

UNIT I
Concept of population, sample, Statistic, parameter and sampling distribution. Standard error of sample means and sample proportion. Statistical hypothesis and its types. One tail and two tail tests. Types of errors, level of significance and critical region, P Value, Procedure for testing of hypothesis.

UNIT II
Estimation and Estimate, Point Estimation and Interval Estimation, confidence Interval. Large sample tests: Tests of significance and confidence Interval for testing of a single mean, single proportion, difference of two means and two proportions.
UNIT III

Exact sampling distributions: t- Statistics. Test for single mean and difference between two means. Paired t-test for difference between two means. F- Statistics or Variance Ratio Test. Assumptions in F-test. Tests of hypothesis of the variance of two populations.

PRACTICAL: 01 CREDIT   **(PREFERABLY THROUGH COMPUTERS)**

List of Practical's:

  I. Large Sample Tests: Testing of significance and confidence intervals for single proportion and differenceof two proportions.

  II. Testing of significance and confidence intervals for single mean and difference of two means. .

  III. Small sample tests: Testing of significance and confidence intervals for single mean and difference oftwo means and paired t – test.

  IV. Testing and confidence intervals of equality of two population variances.

BOOKS RECOMMENDED:

1. Gupta, S.C. and Kapoor, V.K. (2000). Fundamentals of Mathematical Statistics (10th ed.), Sultan Chand and Sons.
2. Das N,G. Statistical Methods Vol I, McGraw Hill Education India.
3. S.P Gupta. Statistical Methods, Sultan Chand and Sons.
4. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003). *An Outline of Statistical Theory*,Vol. I, 4th Ed., World Press, Kolkata.
5. Hogg, R.V. and Tanis, E.A. (2009). *A Brief Course in Mathematical Statistics*. PearsonEducation.
6. Johnson, R.A. and Bhattacharya, G.K. (2001). *Statistics-Principles and Methods*, 4thEd., John Wiley and Sons.
7. Mood, M.A., Graybill, F.A. and Boes, C.D. (2007). *Introduction to the Theory of Statistics*, 3rd Ed., (Reprint).Tata McGraw-Hill Pub. Co. Ltd.
8. Rohatgi, V. K. and Saleh, A.K. Md. E. (2009). *An Introduction to Probability and Statistics*, 2nd Ed., (Reprint) John Wiley