दक्षिण बिहार केन्द्रीय विश्वविद्यालय

Central University of South Bihar

DEPARTMENT OF STATISTICS

School of Mathematics, Statistics and Computer Science

Syllabus of
M.Sc. (Statistics) Based on CBCS
w.e.f.
2019

Proposed Course Structure for M. Sc. (Statistics) Based on CBCS: Effective from July 2019 onwards [96credits]

Course Code	Course Title	Credits
	Semester-I	
MSSTS1001C04	Real Analysis and Linear Algebra	4
MSSTS1002C04	Distribution Theory and Nonparametric Statistics	4
MSSTS1003C04	Survey Sampling and National Development Statistics	4
MSSTS1004C04	Statistical Computing	4
MSSTS1005C04	Lab-I	4
MS***	Elective –I **(To be opted from other Departments)**	4
	Total Credits	**24**
	Semester-II	
MSSTS2001C04	Linear Models and Regression Analysis	4
MSSTS2002C04	Measure Theory and Probability	4
MSSTS2003C04	Statistical Inference	4
MSSTS2004C04	Lab-II	4
MSSTS2005E04-MSSTS2007E04	Elective –II	4
MS***	Elective-III **(To be opted from other Departments)**	4
	Total Credits	**24**
	Semester-III	
MSSTS3001C04	Multivariate Analysis	4
MSSTS3002C04	Project (Part A)	4
MSSTS3003C04	Lab-III	4
MSSTS3004E04-MSSTS3008E04	Elective –IV	4
	Elective –V	4
	Elective –VI	4
	Total Credits	**24**
	Semester-IV	
MSSTS4001C04	Project (Part B)	8
MSSTS4002C04	Lab-IV	4
MSSTS4003E04-MSSTS4007E04	Elective-VII	4
	Elective-VIII	4
MSSTS4008E04-MSSTS4010E04	Elective-X- **(To be Opted from SWAYAM[1] or from Departments outside School of Mathematics, Statistics and Computer Science)**	4
	Total Credits	**24**
	Grand Total	**96**

Semester-II Elective Basket

Course Code	Course Title	Credits
MSSTS2005E04	Demography	4
MSSTS2006E04	Survival Analysis	4
MSSTS2007E04	Operations Research	4

Semester-III Elective Basket

Course Code	Course Title	Credits
MSSTS3004E04	Stochastic Processes	4
MSSTS3005E04	Bayesian Inference	4
MSSTS3006E04	Business Analytics - I	4
MSSTS3007E04	Nonlinear Models	4
MSSTS3008E04	Spatial Data Analysis	4

Semester-IV-Elective Basket

Course Code	Course Title	Credits
MSSTS4003E04	Design of Experiments	4
MSSTS4004E04	Categorical and Directional Data Analysis	4
MSSTS4005E04	Time Series and Forecasting	4
MSSTS4006E04	Statistical Processes and Quality Control	4
MSSTS4007E04	Business Analytics-II	4

Semester-IV SWAYAM Courses[1]- Elective basket* Open to the Department of Statistics

Course Code	Course Title	Credits
MSSTS4008E04	Distribution Free Methods	4
MSSTS4009E04	Econometric Analysis	4
MSSTS4010E04	Probability and Stochastic for Finance	4

***Note:** The basket is non-exhaustive. More Swayam courses of Statistics may be added/removed as per the availability of courses on Swayam portal and need of the students of M.Sc. (Statistics).

Elective Basket Open to the students of other Departments only

Course Code	Course Title	Credit
	Semester-II	
MSSTS2008E04	Statistical Data Analysis-I	4
MSSTS2009E04	Organizing and Visualizing Data*	4
	Semester-III	
MSSTS3009E04	Statistical Data Analysis-II	4

*M.Sc. (Statistics) students may opt this course in respective semesters as non-credit courses.

List of Skill Based/Self Study Courses[2] (Non-Credit)

Course Code	Course Title	Credits
MSSTS2010S04	Latex programming	Non-credit
MSSTS1001S04	Computer Based Data Graphing	Non-credit

[1]One of the SWAYAM courses (Statistics)- Distribution Free Methods, Econometric Analysis, and, Probability and Stochastic for Finance, may be opted by students as the Elective-X during Semester-IV,

[2]The skill based /Self-study courses- Latex and Computer Based Data Graphing have been included to enhance students' skills in scientific typing and computer based writing and presentation.

Note: All the core and elective courses are open to the students of other departments subject to satisfying the prerequisites.

Semester-I

Core Courses

Course Details			
Course Title: Real Analysis and Linear Algebra			
Course Code	MSSTS1001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT- I:
Introduction to real numbers and set theory with related properties. Sequence and series of real numbers and their convergence. Functions of two or more variables. Maxima-minima of functions of two or more variables, constrained maxima – minima of functions.

UNIT-II
The Reimann and Reimann-Stieltjes Integrals: Existence and Properties. Multiple integrals, change of variables in multiple integration. Differentiation under the sign of integral – Leibnitz rule.

UNIT-III
Review of vector spaces and linear transformations, system of liner equations, characteristic roots and vectors, Cayley - Hamilton theorem, minimal polynomial, similar matrices, algebraic and geometric multiplicity of a characteristic root and spectral decomposition of a real symmetric matrix.

UNIT-IV
Gram-Schmidt orthogonalization process, orthonormal basis and orthogonal projection of a vector. Real quadratic forms, reduction and classification of quadratic forms. Partitioned matrices. Generalized inverse.

References

1. Apostol, T. M. (1985). Mathematical Analysis, Narosa Indian Ed.
2. Bartle, R, G. (1976).The Elements of Real Analysis, Second Edition,John Wiley & Sons, Inc., New York.
3. Bartle, R. G. and Sherbert, D. R. (2011). Introduction to Real Analysis, 4th Ed., John Wiley & Sons, Inc., New York.
4. Graybill, F. A. (2002). Matrices with Applications in Statistics, 2nd Ed. Wadsworth.

5. Malik S. C. and Arora, S (2017). Mathematical Analysis, 5th Ed. New Age International Publishers.
6. Miller, K. S. (1975). Advanced Real Calculus, Harper, New York.
7. Rudin, Walter (1976). Principles of mathematical analysis, 3rd Ed., McGraw-Hill, New York.
8. Searle, S. R. (1982): Matrix Algebra for Statistical Applications, John Wiley and Sons Inc.

Course Details			
Course Title: Distribution Theory and Nonparametric Statistics			
Course Code	MSSTS1002C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Brief review of basic distribution theory. Construction of Bivariate Distributions. Function of random variables and their distributions using Jacobian transformation and other tools. Compound, truncated and mixture distributions. Conditional expectation. Markov, Holder, Jensen inequalities and their applications, e.g. Liapounov's inequality. Entropy.

UNIT-II

Non-central distributions: Chi-square distribution, t-distribution, F-distribution and their properties.

UNIT-III

Order statistics, their distribution and properties. Joint and marginal distributions of order statistics. Distribution range, exact and asymptotic distribution of median. Empirical distribution function and its distributional properties, K-S goodness of fit.

UNIT-IV

Rank-test. One-sample location problem, sign test and signed-rank-test, two sample K-S test, two sample location & scale problems. Wilcoxon Mann-Whitney test.

References

1. Balakrishnan, N. and Lai, Cin-Diew (2009). Continuous Bivariate Distributions, 2nd ed. Springer.
2. Casella, G. and Berger, R. L. (2002). Statistical Inference, 2nd ed. Duxbury Press.
3. Daniel, Wayne W. (2000). Applied Nonparametric Statistics, 2nd Ed.Cengage Learning.
4. Feller, W. (1968). An Introduction to Probability Theory and Its Applications, 3rd ed. Wiley.
5. Gibbons, J.D. and Chakraborti, S. (2010). Nonparametric Statistical Inference, 5th ed. Chapman and Hall/CRC.

6. Hogg, R. V. and Craig, A. T. (2012). Introduction to Mathematical Statistics, 7th ed. Pearson Edward (Indian Print).
7. Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd ed., McGraw Hill.
8. Mukhopadhyay, P. (2015). Mathematical Statistics, Books & Allied (P) Ltd.
9. Parzen, E. (1992). Modern Probability Theory and Its Applications, Wiley Eastern.
10. Randles, R.H. and Wolfe, D.A. (1991). Introduction to the Theory of Nonparametric Statistics,
11. Rao, C.R. (2001). Linear Statistical Inference and its Applications, 2nd ed. Wiley.
12. Rohatgi, V. K. and Saleh A. K. Md. E (2015). An Introduction to Probability and Statistics, 3rd ed. Wiley, New York.

Course Details			
Course Title: Survey Sampling and National Development Statistics			
Course Code	MSSTS1003C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Review of basic finite population, sampling techniques-simple random sampling (wr/ wor), stratified random sampling and its allocation problem, post stratification, systematic sampling and related results on estimation of population mean/total.

UNIT-II

Unequal probability sampling: PPS wr/wor methods [including Lahiri's scheme] and related estimators of finite population mean, [Hansen-Hurwitz and Desraj estimators for a general sample size and Murthy's estimators for a sample of size 2].

UNIT-III

Ratio, product and regression estimators based on SRSWOR method of sampling. Two-stage sampling with equal number of second stage unit. Introduction to Double sampling scheme, Cluster Sampling (equal size). Randomized response technique [Warner's model: related and unrelated questionnaire methods]. Introduction to small area sampling.

UNIT-IV

Human Development Index. Estimation of national income-product approach, income approach and expenditure approach. Measuring inequality in incomes, Gini's coefficient, Theil, Sen Poverty Indices, etc.

References

1. Chaubey, P.K. (1995). Poverty Measurement Issues, Approaches and Indices. New Age Publication, New Delhi.
2. Cochran, W.G. (1977). Sampling Techniques, 3rd ed, Wiley.
3. Hedayat, A. S. and Sinha, B.K. (1991). Design and Inference in Finite Population Sampling, Wiley.
4. Mukhopadhyay, P. (2003). Inferential Problems in Survey Sampling. New Age International.
5. Murthy, M.N. (1967). Sampling Theory and Methods. Statistical Publishing Society, Kolkata.
6. Sen, Amatya. (1983). Poverty and Femine. Oxford University Press.
7. Singh, S. (2003). Advanced Sampling Theory with applications, Kulwer Academic Publishers, Netherlands.
8. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). Sampling Theory of Surveys with Applications, Iowa State University Press and Indian Society of Agricultural Statistics.

Course Details			
Course Title: Statistical Computing (with R programming)			
Course Code	MSSTS1004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT I

Getting Started with R, fundamental structures of R-object and vectors, indexing, operators, lists, matrices, dataframes. Introduction to library and packages. Matrix operations- creating a matrix from vector(s), dimension, transpose, inverse, determinant, eigenvalues, eigenvectors. Control structures.

Unit II

Data management-reading CSV files, reading datasets in other formats, concatenate vectors and datasets, create categorical variables from continuous variables, recode a categorical variable, label values and variables, account for missing values, datasets-random sampling, sorting, merging, dropping a variable.

Unit-III

Display cross-classification table, Pearson chi-square statistics, correlation, kappa. Graphics-barchart, histogram, line diagram, scatterplot, boxplot, q-q plot. Adding-title, text, legend, label, line style, line width, line color.

Unit-IV

Simulation from standard probability distributions. Common Statistical procedures-mean and other summary statistics, five number summary, quantiles, centering, normalizing and scaling, confidence interval, MLE.

References

1. Crawley, M. J. (2013). The R Book. 2nd ed. Wiley.
2. Hortan, N. J. and Kleinman, K. (2011). Using R for Data Management, Statistical Analysis, and Graphics. CRC Press, Taylor and Francis Group.
3. James, G. et al. (2014). An introduction to statistical learning with applications in R. Springer, New York.

Course Details			
Course Title: Lab-I (Based on SPSS/MS Excel/R programming, etc.)			
Course Code	MSSTS1005C04	**Credits**	4
L + T + P	0+ 0 + 4	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	120 (P) Hours
Methods of Content Interaction	Demonstration, discussions, lab assignments, etc.		
Assessment and Evaluation	• 40% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 60% - End Semester Examination (University Examination): 48% Written + 12% Viva-voce		

Unit-I

Introduction of SPSS, Getting Help, Data Entry, The Data View Spreadsheet, The Variable View Spreadsheet, Storing and Retrieving Data Files, importing and exporting data, Data File Handling- Sort Cases, Split File, Select Cases, Merge files, Generating New Variables, Constructing Graphical Displays, The Output Viewer, The Chart Editor, Programming in SPSS/ use of syntax editor.

Unit-II

Lab based on core paper MSSTS1002C04

UnitIII

Lab based on core paper MSSTS1003C04

Unit IV

Lab based on core paper MSSTS1004C04

References:

1. SPSS 20.0 Brief Guide – SPSS Inc. ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/20.0/en/client/Manuals/IBM_SPSS_Statistics_Brief_Guide.pdf

2. Landau, S. and Everitt, B.S. (2004). *A handbook of statistical analyses using SPSS*. CRC.
3. Kanji, Gopal K.(2011). *100 Statistical Tests*, 3rd edition, Sage Publications, London in association with Vistaar Publicaion New Delhi.

Core Courses

Course Details			
Course Title: Linear Models and Regression Analysis			
Course Code	MSSTS2001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

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

UNIT-II
Simultaneous estimates of linear parametric functions, tests of hypothesis for one and more than one linear parametric functions, confidence intervals and regions.

UNIT-III
Simple linear regression, multiple and polynomial regressions, logistic regression, orthogonal polynomials.

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

References

1. Cook, R.D. and Weisberg, S. (1982). Residuals and Inference in Regression, Chapman and Hall.
2. Draper, N.R. and Smith, H. (2012). Applied Regression Analysis, 3rd ed. Wiley.
3. Graybill, I.A. (1961). An Introduction to Linear Statistical Models, Vol. I, McGrawHill Book Co. Inc.
4. Hosmer, D. and Lemeshow, S. (2000). Applied Logistic Regression, 2nd ed. Wiley.
5. Kutner, M., Nachtsheim, C., Neter, J. and Li, Willium (2004). Applied Linear Statistical Models, 5th ed. McGraw-Hill/Irwin.
6. Rao, C. R. (2001). Linear Statistical Inference and its Applications, 2nd ed., Wiley.
7. Ronald, C. (1997). Log-linear models and logistic regression. Springer.
8. Seber, G. A. F. and Wild, C. J. (2003). Non-linear Regression. Wiley.
9. Weisberg, S. (2013). Applied Linear Regression, 4th ed., Wiley.

Course Details			
Course Title: Measure Theory and Probability			
Course Code	MSSTS2002C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	EVEN	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Classes of sets, field, sigma field, minimal sigma field, Borel sigma field and induced sigma field, sequence of sets, lim sup, lim inf of a sequence of sets. measure, probability measure and induced probability measure, Cartherdory extension theorem (statement only), Lébesgue and Lébesgue-Stieltjes measures.

UNIT-II

Lebesgue measurable functions, Borel measurable functions, Random variables, Lebesgue Integration: Integration of non-negative measurable functions, Monotone convergence theorem and Fatou's lemma (statement only), Integrable functions and their properties, Dominated convergence theorem (statement only).

UNIT-III

Borel-Contelli lemma, various measures of convergence of sequence of random variables and their interrelationship. Convergence of rational functions of random variables.

UNIT-IV

Characteristic function, inversion theorem, uniqueness theorem, Levy-Cramer continuity theorem (statement only). Examples based on continuous and discrete distributions. Weak and strong law of large numbers and Central limit theorem (CLT) for iid sequences. Applications of CLT.

References

1. Ash, Robert. (1972). Real Analysis and Probability. Academic Press.
2. Barra, G. D. (1981). Measure Theory and Integration, New Age International (P) Ltd. Publisher, New Delhi.
3. Bhat, B.R. (2014). Modern Probability Theory, 4th ed. New Age International.
4. Bilingsley. P. (2012). Measure Theory and Probability. 4th ed. Wiley.
5. Rao, C.R. (2001). Linear Statistical Inference and its Applications, 2nd ed. Wiley Eastern.
6. Rohatgi, V.K. and Saleh, A. K. Md. E. (2015). An Introduction to Probability and Statistics, 3rd ed.Wiley.
7. Royden, H.L.(1988). Real Analysis, 3rd ed. Pearson.

Course Details			
Course Title: Statistical Inference			
Course Code	MSSTS2003C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	EVEN	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I:

Sufficiency, minimal sufficient statistics, completeness, exponential family of distributions. Rao-Blackwell theorem and Lehmann-Scheffe theorem, ancillary statistics, Basu's Theorem.

UNIT-II

CAN and BAN estimators. Method of Fisher-scoring for MLE.

UNIT-III

Most powerful tests, uniformly most powerful tests, uniformly most powerful unbiased tests, uniformly most powerful test for MLR family of distributions. LR test with its asymptotic distribution.

UNIT-IV

Sequential Probability Ratio Test (SPRT), Wald's fundamental Lemma, OC and ASN functions. General decision problem, loss function, risk function, squared error and absolute error loss function.Admissibility, minimaxity and Bayes procedures.

References

1. Berger, J. O. (1993). Statistical Decision Theory and Bayesian Analysis. Springer-Verlag.
2. Casella, G. and Berger, R. L. (2010). Statistical Inference, Wadsworth & Brooks/Cole, California, USA
3. Ferguson T.S. (1967). Mathematical Statistics, Academic Press.
4. Kale, B.K. (2005). A first course in Parametric Inference, 2nd Revised ed., Alpha Science International Ltd.
5. Lehman, E. L. and Casella, G. (2005). Theory of Point Estimation, 2nd ed. Springer.
6. Lehman, E.L. (2005). Testing Statistical Hypothesis, 3rd ed., Springer.
7. Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd ed, McGraw Hill.
8. Rao, C.R. (2001).Linear Statistical Inference, 2nd ed., Wiley.
9. Rohtagi, V.K. and Saleh, A. K. Md. E. (2015). An introduction to probability and Statistics, 3rd ed. Wiley.

Course Details			
Course Title: Lab-II (Based on Minitab/R programming/ SPSS, etc.)			
Course Code	MSSTS2004C04	**Credits**	4
L + T + P	0 + 0 + 4	**Course Duration**	One Semester
Semester	EVEN	**Contact Hours**	120 (P) Hours
Methods of Content Interaction	Demonstrations, discussions, lab assignments, etc.		
Assessment and Evaluation	• 40% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 60% - End Term External Examination (University Examination) : 48% Written + 12% Viva-voce		

UNIT I

Starting Minitab- Minitab Project and Worksheets, Understanding the interface, Worksheet Window, Loading Data in Minitab, Importing data (Non – Minitab type files), Preparing a Worksheet- Move and rename a column, Recode the data, Insert and name a new data column, Assign a formula to a column. Analyze Data- Built-In routines, Command Language, Descriptive Statistics, Graphs- Simple Scatterplot, Simple Histogram and Simple Histogram with fit, Using Minitab commands in the Session Window.

UNIT II

Lab based on problems of core paper MSSTS2001C04

UNIT III

Lab based on problems core paper MSSTS2003C04

UNIT IV

Lab based on problems elective paper MSSTS2005E04/ MSSTS2006E04/ MSSTS2007E04

References:

1. Minitab. Meet Minitab 15. 2007. https://wolfweb.unr.edu/~zal/STAT452/MeetMinitab.pdf
2. Ryan, B., Joiner, B. and Cryer, J. (2005). Minitab Handbook, 5th ed. Brooks/ Cole Cengage Learning.
3. http://cran.r-project.org
4. Getting Started with Minitab 17 https://www.minitab.com/uploadedFiles/Documents/getting-started/Minitab17_GettingStarted-en.pdf
5. Bandi, Federico. (2009). Introduction to Minitab. Summer 2009.

Elective Courses-Semester-II

Course Details			
Course Title: Demography			
Course Code	MSSTS2005E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Sources of demographic data; Evaluation and adjustment of age-sex data; Chandrasekhar-Deming method to check completeness of registration data.

UNIT-II
Measures of fertility, reproduction, mortality and migration. Direct and indirect standardization of rates; demographic transition theory.

UNIT-III
Complete and cohort life tables, construction of abridged life tables, age, period and cohort analyses, Lexis diagram; separating age, period and cohort effects. Stable, stationary and quasi-stable population models.

UNIT-IV
Methods of obtaining population estimates and projections – Mathematical methods, cohort component method of population projections.

References

1. Bhende, A, & Kanitkar, T. (2011). Principles of Population Studies. Himalaya Publishing House, Mumbai.
2. Cox, D.R. (1970). Demography, Cambridge University Press.
3. Henry, S. S, et al. (1980). The Methods and Materials of Demography, Vols. I & II, U.S. Department of Commerce, Bureau of the Census, Washington, D.C.
4. Keyfitz, Nathan. (1977). Introduction to the Mathematics of Population, Addision-Wesley Publishing Company, Massachusetts.
5. Pathak, K. B. and Ram, F. (2015). Techniques of Demographic Analysis, 2nd Revised edn. Himalaya Publishing House.
6. Preston, Samuel, H. and Coale, A. J. (1982). Age Structure, Growth, Attrition and Accession: A New Synthesis. Population Index, Vol. 50(2): 214-226.
7. Ramkumar, R. (2002). Technical Demography. The New Age International Publishers, New Delhi.
8. Spiegelman, M. (1969). Introduction to Demographic Analysis, Harvard University Press.

9. Preston, S.H., Heuveline, P. Guillot, M.(2001). Demography Measuring and Modelling Population Processes. Blackwell Publishing.

Course Details			
Course Title: Survival Analysis			
Course Code	MSSTS2006E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	EVEN	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

Unit-I

Concept of time, order and random censoring, likelihood in the distributions-exponential, gamma, Weibull, lognormal, Pareto, Linear failure rate, inference for these distributions.

Unit-II

Life tables, failure rate, mean residual life and their properties. Introduction to competing risk model, multiple decrement life tables.

Unit-III

Estimation of survival function- actuarial estimator, Kaplan-Meier estimator, estimation under the assumption of IFR/DFR, tests of exponentiality against non-parametric classes, total time on test. Two sample problem- Gehan test, log rank test.

Unit-IV

Semi-parametric regression for failure rate- Cox's proportional hazards model with one and several covariates. Rank test for the regression coefficient. Advances in competing risk model, parametric and non-parametric inference for the model.

References

1. Cox, D. R. and Oakes, D.(1984). Analysis of survival data, Chapman and Hall, New York.
2. Gross, A. J. and Clark, V. A., (1975). Survival Distribution: Reliability applications in the Biomedical Sciences, John Wiley and Sons.
3. Elandt-Johnson, R. E. Johnson N.L.(1999). Survival Models and Data Analysis, John Wiley and Sons.
4. Miller, R. G.(1981). Survival Analysis, John Wiley.
5. Kalbfleisch, J. D. and Prentice, R.(2002). The Statistical Analysis of Failure Time Data, 2nd Edn, John Wiley.
6. Lee, E. T. and Wang, J. W.(2003).Statistical Method for Survival Data Analysis, 3rd edn. John Wiley & Sons.

Course Detail			
Operations Research			
Course Code	MSSTS2007E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

Unit I

Definition and scope of operations research, simplex method, artificial basis technique, revised simplex method. Integer programming: cutting plane and branch and bound algorithms. Principle of duality in LPP, dual-primal relationship, duality theorem and its applications.

Unit II

Allocation models: Transportation problems, Initial feasible solutions and Modified distribution (MODI) Method for optimum solution, Assignment problems and their solutions using Hungarian method, traveling salesman problem.

Unit III

Sequencing and scheduling problems: 2 machine – n job and 3 machine – n job problems, 2 job–n machine problems. Introduction to Dynamic programming.

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.

References

1. Gass, G. I. (2003). Linear Programming – Methods and Applications, 5th rev. Ed., Dover Publications Inc.
2. Gupta, P. K. and Hira, D. S. (2014). Operations Research, 7th ed., S. Chand & Company Ltd, New Delhi.
3. Hadley, G. (1965). Linear Programming, Addison – Wesley.
4. Hiller, F. S. and Libermann, G. J. (2009). Introduction to Operations Research, 9th ed. McGraw Hill.
5. Sharma, J. K. (2013). Operations Research: Theory and Applications, 5th ed. MacMillan India Limited.
6. Starr, M. K. and Miller, D. W. (1962). Inventory Control – Theory and Practice, Prentice Hall.
7. Taha, H. A. (2014). Operations Research: An Introduction, 9th ed. Pearson, Prentice Hall, New Jersey, USA.

Core Courses

Course Details			
Course Title: Multivariate Analysis			
Course Code	MSSTS3001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

Unit-I

Multivariate normal distribution and its properties. Maximum likelihood estimates of mean vector and dispersion matrix, distribution of sample mean vector.

Unit-II

Wishart matrix-its distribution and properties.Hotelling's T^2 statistic-its distribution and application in testing of mean vector for one and more multivariate normal populations. Mahalonobis D^2 statistic and its applications.

Unit-III

Multivariate linear regression model-estimation of parameters.

Unit-IV

Wilk's criteria and linear discriminant functions, Introduction to Principal Components. Concept of Factor Analysis. Cluster Analysis.

References

1. Anderson, T. W. (2003). An Introduction to Multivariate Statistical Analysis. 3rd ed.
2. Bhuyan, K. C. (2008). Multivariate Analysis and Its Applications. New Central Book Agency (P) Ltd. Kolkata, India.
3. Johnson, R. and Wichern, D. W. (2013). Applied Multivariate Statistical Analysis. 6th ed.Pearson.
4. Kotz, S., Balakrishnan, N. and Johnson, N. L. (2000). Continuous Multivariate Distributions, 2nd ed., Models and Applications, Vol. 1. Wiley.
5. Mardia, K. V., Kent, J. T. and Bibby, J. M. (2003). Multivariate Analysis. Academic Press, an Imprint of Elsevier Science.
6. Rencher, A. C. and Christensen, W. F. (2012). Methods of Multivariate Analysis, 3rd ed. Wiley
7. Siotani, M., Hayakawa, T. and Fujikoshi, Y. (1985). Modern Multivariate Statistical Analysis. American Sciences Press, Inc, USA.
8. Srivastava, M. S. and Khatri, C. G. (1979). An Introduction to Multivariate Statistics. North Holland.
9. Sharma, S. (1996). Applied Multivariate Techniques. *John Wiley & Sons, Inc. USA.*

Course Details			
Course Title: Project (Part A) Based on Real Data			
Course Code	MSSTS3002C04	**Credits**	4
L + T + P	1 +1 + 2	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	15 (L) + 15 (T) +30 (P) Hours
Methods of Content Interaction	Lecture, tutorial, discussions, assignments, presentations, field survey, practical, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination) : 50% Progress Report + 20% Presentation and Viva-Voce		

Selection of topic of the project, literature review, study of required methodologies, Authentic Data Repository, preparation of questionnaire (for survey based projects only), conduct of small scale survey (if needed).

Course Details			
Course Title: Lab-III			
Course Code	MSSTS3003C04	**Credits**	4
L + T + P	0 +0 + 4	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	120(P) Hours
Methods of Content Interaction	Lecture, assignments, presentations, practical, etc.		
Assessment and Evaluation	• 40% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 60% - End Semester Examination (University Examination) : 48% Written + 12% Viva-voce		

UNIT-I
Lab based on problems of MSSTS3001C04

UNIT-II, UNIT-III AND UNIT-IV based on elective courses in Semester-III

Course Details			
Course Title: Stochastic Processes			
Course Code	MSSTS3004E04	**Credits**	4
L + T + P	3 +1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorial, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Introduction to Stochastic Processes : Classification of general stochastic processes according to state space and time domain, countable state Markov chains, Chapman – Kolmogorov equations, calculation of n – step transition probabilities and its limit, stationary distribution, classification of states, transient Markov chain, random walk and gambler's ruin problem.

UNIT-II

Discrete state space and continuous time Markov chain: Kolmogorov – Feller differential equations, Poisson process, weighted Poisson Process, Time dependent Poisson Process and inter – arrival time distributions in Poisson Process, pure birth process, pure death process, birth and death process.

UNIT-III

Renewal theory: Elementary renewal theorem and its applications, statement and uses of key renewal theorem, study of residual life time processes, stationary process, weakly stationary and strongly stationary processes.

UNIT-IV

Branching process: definition and examples of discrete time branching process, probability generating function, Galton – Watson branching process, probability of ultimate extinction, and distribution of population size.

References

1. Adke, S. R. and Manjunath, S. M. (1984). An Introduction to Finite Markov Processes, Wiley.
2. Cinlar, E. (2013). Introduction to Stochastic Processes, Prentice Hall.
3. Feller, W. (1968). Introduction to Probability and Applications, New Age India International.
4. Harris, T. E. (1963). The Theory of Branching Processes, Springer-Verlag.
5. Hoel, P. G., Port, S. C. and Stone, C. J. (1991). Introduction to Stochastic Processes, University Book Stall.
6. Karlin, S. and Taylor, H. M. (1995). A First Course in Stochastic Processes, Academic Press.
7. Medhi, J. (2009). Stochastic Processes, 3rd Ed. New Age India International.
8. Ross, S. M. (1996). Stochastic Processes, 2nd. Ed. Wiley.

Course Details			
Course Title: Bayesian Inference			
Course Code	MSSTS3005E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Subjective probability, its existence and interpretation.Prior distribution, Subjective determination of prior distribution.Subjective and objective priors.Improper priors, Non-informative (default) priors, Invariant priors.Conjugate prior families, Construction of conjugate families using sufficient statistics of fixed dimension, Mixtures of conjugate priors, Hierarchical priors. Maximum Entropy Prior.

UNIT-IV

Bayes Theorem for random variables.Posterior distribution and its calculation for discrete and continuous distributions.

UNIT-III

Point estimation, credible sets, testing of hypotheses and Predictive Inference. Comparison with classical procedures.

UNIT-IV

Asymptotic expansion for the posterior density. Bayesian calculation, Monte-Carlo Integration and Markov chain Monte Carlo techniques (without proof).

References

1. Berger, J.O.(1993). Statistical Decision Theory and Bayesian Analysis. Springer-Verlag.
2. Bernado, J.M. and Smith, A.F.M. (2000). Bayesian Theory. Wiley.
3. Box, G.P. and Tiao, G.C.(1992). Bayesian Inference in Statistical Analysis. Addison-Wesley.
4. Gelman, A., etal. (2004). Bayesian Data Analysis. Chapman Hall/CRC.
5. Gemerman, D.,et al. (2006). Markov Chain Monte Carlo:Stochastic Simulation for Bayesian Inference,2nd ed. Chapman Hall.
6. Ghosh, J. K., Delampady, M. and Samanta, T. (2006). An Introduction to Bayesian Analysis, Theory and Methods. Springer.
7. Lee, P. M. (2012). Bayesian Statistics: An Introduction, 4th ed. John Wiley & Sons.
8. Leonard, T. and Hsu, J.S.J. (2001). Bayesian Methods. Cambridge University Press.
9. Robert, C.P.(2007). The Bayesian Choice:A Decision Theoretic Motivation,2nd ed. Springer.
10. Robert, C.P. and Casella, G. (2010). Monte Carlo Statistical Methods. Springer.

Course Details			
Course Title: Business Analytics-I (Predictive Modeling)			
Course Code	MSSTS3006E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Introduction, Prediction Versus Interpretation, Key Ingredients of Predicting Models. Statistical Learning, Supervised Versus Unsupervised Learning, Regression Versus Classification Problem, Machine Learning, Assessing Model Accuracy, Basics of Decision Trees, Support Vector Machines, etc.

UNIT-II

Predictive Modeling Process, Data Pre-processing, Over Fitting, etc.Measuring Predictor Importance, Feature Selection, etc.

UNIT-III

Regression Models: Linear Regression, Nonlinear Regression Models. Regression Trees and Rule-Based Models.

UNIT-IV

Classification Models: Measuring Performance in Classification Models, Discriminant Analysis and Other Linear Classification Models, Nonlinear Classification Models. Classification Trees and Rule-based Models.

References

1. Bishop, C. (2010). Pattern Recognition and Machine Learning. Springer.
2. Harrington, P. (2012). Machine Learning in Action. Dreamtech Press.
3. Hastie, T.,Tibshirani, R., and Friedman, J. (2008). The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, Second Edition.
4. Izenman, A. J. (2013). Modern Multivariate Statistical Techniques: Regression, Classification, and Manifold Learning, 2nd ed. Springer.
5. James, G., Witten, D., Hastie, T. and Tibshirani, R. (2013). An Introduction to Statistical Learning with Applications in R. Springer.
6. Kuhn, M. and Johnson, K. (2013). Applied Predictive Modeling. Springer.
7. Silver, N. (2012). The Signal and the Noise: The Art and Science of Prediction. Allen Lane, Penguin Books Ltd.

Course Details			
Course Title: Nonlinear Regression Models			
Course Code	MSSTS3007E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Review of Simple Linear Regression, Multiple Regression and General Linear Regression Model. Regression Models for Quantitative and Qualitative Predictors.

UNIT-II
Introduction to Nonlinear Regression, Least Squares Estimation in Nonlinear Regression, Introduction to Neural Network Modeling, Neural Network as Generalization of Linear Regression

UNIT-III
Generalized linear models and link functions, Poisson regression and negative binomial regression, Logistic Regression, Probit Regression, etc.

UNIT-IV
Regression model diagnostics.

References

1. Bates, D. M., and Watts, D. G.(1988). *Nonlinear Regression Analysis and Its Applications*, Wiley, New York.
2. Gallant, A. R. (1987). *Nonlinear Statistical Models*, Wiley, New York.
3. Kutner, M. H., Nachtsheim, C. J. and Li, W.(2013). *Applied Linear Statistical Models,* fifth edition, McGraw Hill Education (India) Private Limited, New Delhi.
4. Ratkowsky, D. A.(1983). *Nonlinear Regression Modeling, Marcel Dekker,* New York.

Course Details			
Course Title: Spatial Data Analysis			
Course Code	MSSTS3008E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Geostatistical data, Lattice data, Point patterns.

UNIT-II
Ripley's & Cressie's approaches to analysis of spatial data.Basic stochastic processes.Spatial sampling.

UNIT-III
Autoregression and Autocorrelation. Point patterns – Distance methods, Nearest-neighbor methods. Variogram&Correlogram.Variogram model fitting.

UNIT-IV
Spatial Prediction and Kriging, Spatial models on Lattices for discrete and continuous data. GIS and its applications.

References

1. Cressie, N.A. (2015). Statistics for Spatial Data. Rev. ed. Wiley
2. Ripley, B.D. (2004). Spatial Statistics. Wiley.
3. Statistical Packages for Geological Data.

Semester-IV

Core Courses

Course Details			
Course Title: Project (Part B)			
Course Code	MSSTS4001C04	**Credits**	8
L + T + P	1 + 1 + 2	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	15 (L)+15 (T)+30 (P) Hours
Methods of Content Interaction	Lecture, practical, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination) : 50% Project Report + 20% Presentation and viva		

Statistical analysis, final project report writing and presentation of work.

Course Details			
Course Title: Lab-IV			
Course Code	MSSTS4002C04	**Credits**	4
L + T + P	0 + 0 + 4	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	120 (P) Hours
Methods of Content Interaction	Lecture, practical, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 40% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 60% - End Semester Examination (University Examination) : 48% Written + 12% Viva-voce		

UNIT-I, UNIT-II, UNIT-III and **UNIT-IV** are based on the Elective courses of Semester-IV

Elective Courses-Semester-IV

Course Details			
Course Title: Design of Experiments			
Course Code	MSSTS4003E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Review of linear estimation and basic designs like CRD, RBD and LSD, missing plot technique – General theory and applications, analysis of covariance for CRD and RBD.

UNIT-II
Incomplete block design: Balanced Incomplete Block Design (BIBD) – Intrabloc Analyis, recovery of interblock information. Simple lattice designs, two-associate partially balanced incomplete block designs: association scheme, group divisible designs.

UNIT-III
General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects; Study of 2^2, 2^3 and 3^2 factorial experiments in randomized blocks, complete and partial confounding.

UNIT-IV
Split plot and strip – plot experiments.Introduction to response surface methodology.

References

1. Box, G. E. P. and Draper, N. R. (2007). Response Surfaces, Mixtures and Ridge Analyses, 2nd ed. Wiley.
2. Das, M.N. and Giri, N. (1986). Design and Analysis of Experiments. 2nd Ed. Wiley Eastern.
3. Dean, A. and Voss, D. (1999). Design and Analysis of Experiments. Springer.
4. Dey, A. (1986). Theory of Block Designs. Wiley Eastern.
5. Giri, N. (1986). Analysis of Variance. South Asian Publishers.
6. Joshi, D.D. (1987). Linear Estimation and Design of Experiments, Wiley Eastern.
7. Mathews, P. (2005). Design of Experiments with MINITAB, Pearson Education (Singapore) Pt. Ltd.
8. Montgomery, D. C. (2008). Design and Analysis of Experiments. 8th Ed. Wiley.

Course Details			
Course Title: Categorical and Directional Data Analysis			
Course Code	MSSTS4004E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Categorical Data analysis: Categorical data, measures of association and contingency tables.

UNIT-II
Estimation in complete and incomplete tables; missing data and EM algorithm for contingency tables and goodness-of- fit tests.

UNIT-III
Generalized Linear Models for discrete data; Poisson and Logistic (Binary and Multinomial) Regression; Log-linear models.

UNIT-IV
Directional Data Analysis: Circular data, examples and differences with linear data; Data representations and Summary measures. Probability models on the circle- CN and Wrapped Stable distributions. Inference for the CN model- one, two and k-samples; Goodness-of-Fit tests.Tests for Isotropy; Predictive Inference.Circular-circular, Circular-linear, Linear-circular Regression.

References

1. Agresti, A. (2007). Introduction to Categorical Data Analysis. 2nd ed. Wiley
2. Fisher, N.I. (2001). Analysis of Circular Data, Cambridge University Press.
3. Jammalamadaka, S.R. andSenGupta, A. (2001). Topics in Circular Statistics, World Scientific.
4. Kendall, M.and Stuart, A. (1991). The Advanced Theory of Statistics, vol.2: Inference and Relationship, 5th ed. New York: Macmillan.
5. Little, R.J. and Rubin, D. B. (2002). Statistical Analysis with Missing Data. 2nd ed. Wiley.
6. Mardia, K.V. (1972). Statistics of Directional Data. Academic Press.
7. Rao, C. R. (1973). Linear Statistical Inference and its Applications, 2nd ed. Wiley.
8. SenGupta, A. (2005). DDSTAP 1.1 – Statistical Analysis Package for Directional Data. Indian Statistical Institute. Kolkata

Course Details			
Course Title: Time Series and Forecasting			
Course Code	MSSTS4005E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I
Time series as a stationary or nonstationary stochastic process, time domain analysis based on correlogram, sample autocovariance function (acvf), autocorrelation function (acf), Partial Autocorrelation Function.

UNIT-II
Exploratory time Series analysis, tests for trend and seasonality, exponential and moving average smoothing. Holt and Winters smoothing, forecasting based on smoothing.

UNIT-III

AR(p) process, MA(q) process, mixed ARMA(p,q) process, stationarity and invertibility conditions, random walk model, ARIMA(p,d,q) model, implications and tests for stationarity, unit root test, correlogram and role of acf and pacf in process identification, estimation of parameters of AR, MA, ARMA and ARIMA models, forecasting by Box-Jenkins procedures.

UNIT-IV

Frequency domain analysis based on the spectral density function, computations based on Fourier transform, spectra of AR (1) and MA (1) models, periodogram and its relationship with acvf.

References

1. Anderson, T.W. (1994). The Statistical Analysis of Time Series, Wiley, N.Y.
2. Bloomfield, P. (2013). Fourier analysis of Time Series—An Introduction, 2nd ed. Wiley.
3. Box, G.E.P. and G.M. Jenkins(2015). Time Series Analysis, Forecasting and Control 5thed.
4. Brockwell, P.J. and Davis, R.A. (2009). Time Series: Theory and Methods (Second Edition), Springer-Verlag.
5. Chatfield, C.(2003). The Analysis of Time Series: An Introduction. 6thed.
6. Findley, D.F. (Ed.) (1981). Applied Time Series Analysis II, Academic Press.
7. Fuller, W.A. (2008). Introduction to Statistical Time Series, 2nd. ed. John Wiley, N.Y.
8. Granger, C.W.J. and Hatanka, M. (1964). Spectral Analysis of Economic Time Series, Princeton Univ. Press, N.J.
9. Granger, C.W.J. and Newbold (1984). Forecasting Econometric Time Series, Third Edition, Academic Press.
10. Kendall, Sir Maurice and Ord, J.K. (1990). Time Series (Third Edition), Edward Arnold.
11. Kendall, M.G. and Stuart, A. (1966). The Advanced Theory of Statistics, Volume 3, Charles Griffin, London.
12. Koopmans, L.H. (1995). The spectral Analysis of Time Series, 2nd ed. Academic Press.
13. Montgomery, D.C. and Johnson, L.A. (1977). Forecasting and Time Series Analysis, McGraw Hill.
14. Nelson, C.R. (1973). Applied Time Series for Managerial Forecasting, Holden-Day.
15. Priestley, M.B. (1981). Spectral Analysis & Time Series, Griffin, London.

Course Details			
Course Title: Statistical Processes and Quality Control			
Course Code	MSSTS4006E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Basic concepts of quality, statistical process-monitoring and control. Tools of Continuous Quality Improvement.

UNIT-II

General theory and review of control charts for attribute and variable data, O.C. and A.R.L. of control charts; Moving average and exponentially weighted moving average charts: Cu-sum charts using V-masks and decision intervals, Multivariate statistical process control, Hotelling's T^2 control chart.

UNIT-III

Acceptance sampling plans for attribute inspection; single, double and sequential type sampling plans and their properties; Plans for inspection by variables for one-sided and two-sided specifications.

UNIT-IV

Capability indices Cp, Cpk and Cpm; estimation, confidence intervals and tests of hypotheses relating to capability indices for normally distributed characteristics, Quality in the service sector and TQM.

References

1. Mitra, A. (2014). Fundamentals of Quality Control and Improvement, 3rd ed. Wiley, India.
2. Montgomery, D.C. (2012). Statistical Quality Control: A Modern Introduction, 6th ed. Wiley,India.
3. Wetherill, G.B. and Brown, D.W (1991). Statistical Process Control: Theory and Practice. 3rded. Chapman and Hall, USA.

Course Details			
Course Title: Business Analytics-II (Data Mining)			
Course Code	MSSTS4007E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT-I

Principles of Data Mining and basic concepts. Data Pre-processing and exploration.

UNIT-II

Basic and Other Techniques for Cluster Detection.Decision Tree Induction for Classification and other Classification Techniques.

UNIT-III

Techniques for Mining Boolean Association Rules.Mining Techniques for Other Types of Association.

UNIT-IV

Text Mining and Web mining.Applications of WEKA software and IBM SPSS Data Modeler software.

References

1. Du, H. (2010). Data Mining Techniques and Applications. Cenage Learning.
2. Han, J., Kamber, M. and Pei, J. (2012). Data Mining: Concepts and Techniques: An Introduction. Elsevier, The Morgan Kaufmann Series, Third Edition.
3. Nisbet, R., Elder, J. and Miner, G. (2009). Handbook of Statistical Analysis and Data Mining Applications.Elsevier.
4. Roiger, R. and Geatz, M. (2003). Data Mining: A Tutorial Based Primer. Pearson Education, Inc.
5. Witten, I. H., Frank, E. and Hall, M. A. (2011). Data Mining: Practical Machine Learning Tools and Techniques. Elsevier, The Morgan Kaufmann Publishers, Third Edition.
6. Rao, C.R., Wegman, E. G., and Solka, G. L. (2005). Data Mining and Data Visualisation. Handbook of Statistics, Vol. 24 (Edited by Rao, Wegman and Solka). Elsevier.
7. Govindaraju, V. and Rao, C.R. (2013). Machine Learning: Theory and Applications. Handbook of Statistics, Vol. 31(Edited by Govindaraju and Rao). Elsevier.
8. Izenman, A.J. (2008). Modern Multivariate Statistical Technique: Regression, Classification and Manifold Learning. Springer.

Elective Basket Open to students of other Departments only

Course Details			
Course Title: Statistical Data Analysis-I (Using SPSS/Minitab/R programming)			
Course Code	MSSTS2008E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 30 (P) Hours
Methods of Content Interaction	Lecture, demonstrations, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT I

Definitions and concepts of population, sample, parameters, statistics. Merits and demerits of statistics. Construction of frequency distributions, Graphical representations of a frequency distribution (histogram, frequency polygon, cumulative frequency distributions (Ogives),

UNIT II

Descriptive Statistics-central tendency and its measures, dispersion and its measures, moments, skewness and kurtosis and their measures.

UNIT III

Correlation, Product Moment Correlation Coefficient, Rank Correlation Coefficient, Multiple and Partial Correlation Coefficients. Symmetric and asymmetric distributions.

UNIT VI

Concept and definition of simple random and stratified sampling. Methods of drawing simple random samples, Concepts of sampling and non-sampling errors, Nonprobability sampling methods.

References

1. Aczel, A. D. and Sounderpandian, J.(2006). *Complete Business Statistics*, sixth edition, Tata McGraw-Hill Publishing Company, New Delhi.
2. Gupta, S. C.(2009). *Fundamentals of Statistics*, Himalaya Publishing House, New Delhi.
3. Levin, R. I. and Rubin, D. S. (2009). *Statistics for Management*, seventh edition, Prentice Hall (An imprint of Pearson), New Delhi.
4. Levine, D. M., Stephan, D. F. and Szabat, K. A. (2016). *Statistics for Managers, Using Microsoft Excel,* seventh edition, Pearson India Education Services Pvt. Ltd, Noida 201309.
5. Sharma, J.K. (2007). *Business Statistics*, second edition, Dorling Kindersley (India) Pvt. Ltd. Delhi, 110092.
6. Bandi, Federico. (2009). Introduction to Minitab. Summer 2009.
7. Crawley, M. J. (2013). The R Book. 2nd ed. Wiley.
8. Getting Started with Minitab 17

https://www.minitab.com/uploadedFiles/Documents/getting-started/Minitab17_GettingStarted-en.pdf
9. Hortan, N. J. and Kleinman, K. (2011). Using R for Data Management, Statistical Analysis, and Graphics. CRC Press, Taylor and Francis Group.
10. http://cran.r-project.org
11. James, G. et al. (2014). An introduction to statistical learning with applications in R. Springer, New York.
12. Landau, S. and Everitt, B.S. (2004). *A handbook of statistical analyses using SPSS.* CRC.
13. Minitab. Meet Minitab 15. 2007. https://wolfweb.unr.edu/~zal/STAT452/MeetMinitab.pdf
14. Ryan, B., Joiner, B. and Cryer, J. (2005). Minitab Handbook, 5th ed. Brooks/ Cole Cengage Learning.
15. SPSS 20.0 Brief Guide – SPSS Inc. ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/20.0/en/client/Manuals/IBM_SPSS_Statistics_Brief_Guide.pdf

Course Details			
Course Title: Organizing and Visualizing Data (Using SPSS/Minitab/R programming)			
Course Code	MSSTS2009E04	**Credits**	4
L + T + P	2+ 0 + 2	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	30 (L) + 60(P) Hours
Methods of Content Interaction	Lecture, demonstrations, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Semester Examination (University Examination)		

UNIT I

Data cleaning, data integration, data reduction, data transformation and data discretization; Measurement scales: nominal scale, ordinal scale, interval scale and ratio scale.

UNIT II

Organizing categorical data includes the summary table and the contingency table. Visualizing categorical data includes Bar Chart, Side by Side-Bar Chart, Pie Chart, Pareto Chart. Circular data visualization.

UNIT III

Organizing numerical data includes stacked and unstacked data, the ordered array, the frequency distribution, the cumulative frequency distribution.

UNIT IV

Visualizing numerical data includes Stem and Leaf Display, Histogram, Polygon, Cumulative Percentage Polygon (Ogive), Boxplot, Interval Plot, Scatterplots, Area Graph, Three-dimensional Scatterplots and Surface Plots; Challenges in visualizing data.

References

1. Aczel, A. D. and Sounderpandian, J. (2006). *Complete Business Statistics*, sixth edition, Tata McGraw-Hill Publishing Company, New Delhi.
2. Daniel, W. W. (1990). *Applied Nonparametric Statistics*, second edition, Duxbury, CA 93950, USA.
3. Han, J., Kamber, M. and Pie, J. (2012). *Data Mining: Concepts and Techniques*, third edition, Morgan Kaufmann Publishers, An imprint of Elsevier, MA 02451, USA.
4. Levine, D. M., Stephan, D. F. and Szabat, K. A. (2016). *Statistics for Managers, Using Microsoft Excel,* seventh edition, Pearson India Education Services Pvt. Ltd, Noida 201309.
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Course Details			
Course Title: Statistical Data Analysis-II (Using SPSS/Minitab/R programming)			
Course Code	MSSTS3009E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 30 (P) Hours
Methods of Content Interaction	Lecture, tutorials, discussions, assignments, presentations, etc.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

UNIT I
Least square estimation, simple linear regression and multiple regression. Categorical data and logistic regression, Poisson regression. Test for normality, q-q plot.

UNIT II
Standard normal variate, Types of error, Null and alternative hypothesis, Tests of significance for large samples, Tests based on Chi-square statistic, Student's t and paired t tests.

UNIT III
Analysis of variance and its assumptions, one-way and two-way classification of ANOVA.

UNIT IV
Dimension-reduction techniques, classification and clustering.

References

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Marking Scheme of Elective Courses offered to Students of Other Departments

Paper	Examination					
	Theory			Lab		
	Total	CIE	ESE	Total	CIE	ESE
MSSTS2008E04	75	25	50	25	5	20
MSSTS2009E04	50	15	35	50	10	40
MSSTS3009E04	75	25	50	25	5	20

CIE: Continuous Internal Evaluation
ESE: End Semester Examination