VIDYASAGAR UNIVERSITY

Midnapore, West Bengal

PROPOSED CURRICULUM&SYLLABUS (DRAFT) OF

B.Sc. (HONOURS / HONOURS WITH RESEARCH)

MAJOR IN STATISTICS

4-YEAR UNDERGRADUATE PROGRAMME

(w.e.f. Academic Year 2023-2024)

Based on

Curriculum & Credit Framework for Undergraduate Programmes

(CCFUP), 2023 & NEP, 2020

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VIDYASAGAR UNIVERSITY
B.SC. (HONOURS/ HONOURS WITH RESEARCH) MAJOR IN STATISTICS
(under CCFUP, 2023)

Level	YR.	SEM	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
								CA	ESE	TOTAL
B.Sc. (Hons./ Hons. with Research)	4th	VII	**SEMESTER-VII**							
			Major-14	STSHMJ14	T: Statistical Inference III; P: Practical	4	3-1-0	15	60	75
			Major-15	STSHMJ15	T: Sample Survey and Official Statistics; P: Practical	4	3-1-0	15	60	75
			CRM	STSHCRM	T: Research and Publication Ethics; P: Practical	4	3-0-1	15	60	75
			Major Elective-03	STSHDS 03	T: Regression Analysis and Econometrics; P: Practical Or Financial Time Series Data Analysis; P: Practical	4	3-0-1	15	60	75
			Minor-07 (Disc.-I)	STSMIN07	Application of Statistics; P: Practical *(To be taken from other Discipline)*	4	3-1-0/ 3-0-1	15	60	75
					Semester-VII Total	**20**				**375**

MJ = Major, MI = Minor Course, DSE = Discipline Specific Elective Course, CRM= Compulsory Research Methodology, CA= Continuous Assessment, ESE= End Semester Examination, T = Theory, P= Practical, L-T-P = Lecture-Tutorial-Practical

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SEMESTER-VII

MAJOR COURSES (MJ)

MJ-14: Statistical Inference III **Credit 04 (Full Marks: 75)**

MJ – 14T: Statistical Inference III **Credit 03**

Unit 1:

Interval estimation: confidence intervals and confidence sets, confidence coefficient, confidence intervals for parameters of the univariate normal; differences of means of two independent homoscedastic normal distributions; resampling procedures in estimation: the jackknife and bootstrap.

Unit 2:

Need for nonparametric inference, sample median and interquartile range as point estimates of location and dispersion, distribution-free interval estimation of population quantile, tolerance interval, sign test, Wilcoxon signed-rank test, Mann–Whitney test, median test and tests based on Kendall's τ and Spearman's rank correlation coefficient.

Unit 3:

Runs test for randomness, Kolmogorov–Smirnov goodness-of-fit test, one-sample location and scale problems, Wilcoxon signed-rank statistic, median test, two-sample homogeneity problem, Wolfowitz runs test and the two-sample Kolmogorov–Smirnov test.

Unit 4:

Sequential Analysis: Need for sequential inference, Sequential tests, SPRT and its properties, fundamental identity, OC and ASN, Wald's equation for ASN, Wald's SPRT with illustrations, Determination of boundaries approximately, Expression for OC and ASN functions (without proof) of tests regarding parameters of binomial, Poisson and normal distributions.

MJ – 14P: Statistical Inference III **Credit 01**

List of Practical

1. Test for randomness based on the total number of runs.
2. Kolmogorov–Smirnov test for one sample.
3. Sign test.
4. Signed-rank test.
5. Wilcoxon–Mann–Whitney test.
6. Kruskal–Wallis test.

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Suggested Readings

- Goon, A. M., Gupta, M. K., and Dasgupta, B. (2001). Fundamentals of Statistics, Vol. 1. World Press.
- Gibbons, J. D., and Chakraborti, S. (2011). Nonparametric Statistical Inference (5th ed.). CRC Press. (Or 6th ed., 2021, Chapman and Hall/CRC)
- Goon, A. M., Gupta, M. K., and Dasgupta, B. (2019). An Outline of Statistical Theory, Vol. 2 (4th ed.). World Press.
- Randles, R. H., and Wolfe, D. A. (1979). Introduction to the theory of nonparametric statistics. John Wiley & Sons.
- Rohatgi, V. K. (1984). Statistical Inference. John Wiley.
- Rao, C. R. (1973). Linear statistical inference and its applications (2nd ed.). John Wiley & Sons.

MJ-15: Survey Sampling and Indian Official Statistics Credit 04 (Full Marks: 75)

MJ – 15T: Survey Sampling and Indian Official Statistics **Credit 03**

Unit 1:

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling. Basic principles of sample survey. Simple random sampling with and without replacement: technique, estimates of population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

Unit 2:

Stratified random sampling: technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS, practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: technique, estimates of population mean and total, variances of these estimates ($N = nk$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

Unit 3:

Introduction to Ratio and Regression methods of estimation: first approximation to the population mean and total (for SRS of large size), MSE of these estimates and estimates of the associated variances, MSE in terms of the correlation coefficient for regression method of estimation, and their comparison with SRS. Cluster sampling (equal clusters only): estimation of population mean and its variance, comparison (with and without randomly formed clusters). Concept of subsampling. Two-stage Sampling: estimation of population mean and variance of the estimate.

Unit 4:

An outline of the present official statistical system in India: methods of collection of official statistics, their reliability and limitations. Role of the Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Registered General Office and National Statistical Commission. Government of India's

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Principal publications containing data on topics such as agriculture, price, population, industry, finance and employment. National Income: basic idea and a brief description of income, expenditure and production approaches.

MJ – 15P: Survey Sampling and Indian Official Statistics Lab **Credit 01**

List of Practical

1. To select an SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square, and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size.
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods. Compare the efficiencies of the above two methods relative to SRS.
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend.
7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate.
9. Two-stage Sampling.

Suggested Readings

- Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
- Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
- Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
- Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
- Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics, Vol- II, World Press.
- Guide to current Indian Official Statistics, Central Statistical Office, GOI, and New Delhi. http://mospi.nic.in/

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COMPULSORY RESEARCH METHODOLOGY (CRM)

[for both Honours and Honours with Research Students]

CRM: Research and Publication Ethics Credit 04 (Full Marks: 75)

CRM-T: Research and Publication Ethics **Credit 03**

Unit 1: Philosophy and Ethics

i. Introduction to Philosophy: definition, nature and scope, concept, branches
ii. Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

Unit 2: Scientific Conduct

i. Ethics with respect to science and research
ii. Intellectual honesty and research integrity
iii. Scientific misconduct: Falsification, Fabrication and Plagiarism (FFP)
iv. Redundant publications: duplicate and overlapping publications, salami slicing
v. Selective reporting and misrepresentation of data

Unit-03: Publication Ethics

i. Publication ethics: definition, introduction and importance
ii. Best practices/standards setting initiatives and guidelines: COPE, WAME etc.
iii. Conflicts of interest
iv. Publication misconduct: Definition, concept, problems that lead to unethical behavior and vice versa, types
v. Violation of publication ethics, authorship and contributorship
vi. Identification of publication misconduct, complaints and appeals
vii. Predatory publishers and journals

CRM-P: Research and Publication Ethics Lab **Credit 01**

List of Practical

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU: UGC-CARE list of journals
4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.
5. Software tools: Use of reference management software like Mendeley, Zotero, etc., and anti-plagiarism software like Turnitin, Urkund

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Suggested Readings

- Resnik, D. B. (2020). The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust. Springer.
- Shamoo, A. E., & Resnik, D. B. (2015). Responsible Conduct of Research (3rd ed.). Oxford University Press.
- COPE (Committee on Publication Ethics). (2017). Code of Conduct and Best Practice Guidelines for Journal Editors. Retrieved from https://publicationethics.org
- Steneck, N. H. (2007). ORI Introduction to the Responsible Conduct of Research. Office of Research Integrity, U.S. Department of Health & Human Services.
- Wager, E., & Kleinert, S. (2011). Responsible Research Publication: International Standards for Authors. In Mayer, T., & Steneck, N. (Eds.), Promoting Research Integrity in a Global Environment (pp. 309–316). World Scientific.
- Sugimoto, C. R., & Larivière, V. (2018). Measuring Research: What Everyone Needs to Know. Oxford University Press.

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MAJOR ELECTIVE (DSE)

MJDSE - 3: Regression Analysis and Econometrics **Credit 04 (Full Marks: 75)**

MJDSE 3T: Regression Analysis and Econometrics **Credit 03**

Unit 1:

Types of data, correlation vs. causation between variables. Concept of regression: classical regression theory, assumptions, matrix formulation, OLS estimation of the linear regression model, and properties of OLS estimators. Regression as conditional expectation.

Linear regression as a linear model (LM), Gauss-Markov theorem, BLUE properties, variance decomposition and classifications of LM; Tests of significance of a model and its individual parameters; Measuring the quality of fit: R-squared;

Model Building – Variable Selection and Model Diagnosis: specification of candidate models; Nested-model comparison and partial F-tests, forward, backward and stepwise variable selection with cautions, Mallow's Cp, adjusted R-squared, AIC and BIC; Prediction from a fitted model;

Unit 2:

Multicollinearity: detection (condition number and VIF), tolerance, consequences of multicollinearity for estimation, remedial measures;

Heteroscedasticity: meaning, graphical diagnosis, Breusch–Pagan and White tests, removal of heteroscedasticity, weighted least-squares, logarithmic and power transformation of data.

Non-normality of Errors: Graphical evaluations – histogram and Q–Q plot; Shapiro–Wilk and Jarque–Bera tests, practical limits of normality tests, Box-Cox transformations;

Auto-correlation (concept only);

Influence Diagnostics: leverage, studentized residuals, Cook's distance, DFFITS, DFBETAS; Distinguishing outliers in response variable and predictors;

Unit 3:

Qualitative predictors: indicator variables, reference categories and dummy-variable trap, models with one or more categorical predictors, parameter interpretation, interactions between quantitative and qualitative predictors; testing differences in slopes and intercepts.

Non-linear Regression for continuous response: piecewise regression, splines and scatter plot smoothing.

Unit 4:

Logistic Regression: binary response, Log-odds, odds ratio, Bernoulli model and logistic link, its fitting using maximum likelihood inference for grouped and ungrouped data, diagnostics, variable selection, goodness-of-fit, classification table, sensitivity/specificity and ROC concepts.

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Poisson Regression: count response and Poisson model, canonical log link, interpretation through rate, ratios, deviance, Pearson diagnostics and overdispersion.

MJDSE– 3P: Regression Analysis and Econometrics Lab **Credit 01**

List of Practical

1. Problems on fitting linear regression to a continuous variable using variable selection
2. Problems on outlier detection and influence diagnostics
3. Problems on several diagnostics for checking the violations of OLS assumptions
4. Problems on using dummy variables
5. Problems on fitting logistic and Poisson regression

Suggested Readings

- Seber, G. A. F., & Lee, A. J. (2003). Linear Regression Analysis (2nd ed.). John Wiley & Sons.
- Draper, N. R., & Smith, H. (1998). Applied Regression Analysis (3rd ed.). John Wiley & Sons.
- Cook, R. D., & Weisberg, S. (1982). Residuals and Influence in Regression. Chapman & Hall.
- Chatterjee, S., & Hadi, A. S. (2012). Regression Analysis by Example (5th ed.). John Wiley & Sons.
- Johnston, J. (1984). Econometric Methods (3rd ed.). McGraw-Hill.
- Judge, G. G., Griffiths, W. E., Hill, R. C., Lütkepohl, H., & Lee, T. C. (1985). The Theory and Practice of Econometrics (2nd ed.). John Wiley & Sons.
- Gujarati, D. N., Porter, D. C., & Pal, M. (2022). Basic Econometrics (6th ed.). McGraw Hill.
- Ryan, T. P. (2008). Modern Regression Methods (2nd ed.). John Wiley & Sons.

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MJDSE - 3: Financial Time Series Analysis **Credit 04 (Full Marks: 75)**

MJDSE - 3T: Financial Time Series Analysis **Credit 03**

Unit 1:

Stationary Time Series: strongly and weakly stationary processes, ACF and PACF plots, AR, MA and ARMA models, stationarity and invertibility conditions, fitting of AR, MA and ARMA processes, diagnostics checking for stationary processes.

Non-stationary time series: asset data over time and preliminary graphical analysis; return and log-return data for a financial asset. Non-stationarity- random walk and other stochastic models. Types of non-stationarity - integrated time series and time series with stochastic trend. Test of stationarity - graphical method, unit root test, Dickey-Fuller (DF) test, and Augmented DF test. ARMA family of models - ARIMA and Seasonal ARIMA modelling using Box-Jenkins approach.

Unit 2:

Volatility: concept of volatility, volatility clustering, conditional heteroscedasticity. Volatility modelling and forecasting - ARCH, GARCH, E-GARCH models and their illustrative applications in real data and associated forecasting. Properties and applications of these models to real-life financial data.

Unit 3:

Asset Portfolio Risk Measures: definition of risk, value at risk (VaR), parametric and nonparametric approaches to VaR estimation. Expected Shortfall. Density forecasting of risk using ARCH models. Risk measure β.

Unit 4:

Capital asset pricing model (CAPM): share price, modern portfolio theory, CAPM modelling. Empirical evaluation of pricing data: data selection, modification of CAPM, statistical methods for testing CAPM

MJDSE – 3P: Financial Time Series Analysis Lab **Credit 01**

1. Problems on ARMA, ARIMA and SARIMA model fitting
2. Problems on ARCH, GARCH, and EGARCH model fitting
3. Problems on CAPM modelling

Suggested Readings

- Tsay, R.S. (2010): Analysis of Financial Time Series (3rd Ed.), John Wiley.
- Brockwell & Davis (2016): Introduction to Time Series and Forecasting (3rd Ed.), Springer.
- Brooks, C. (2019): Introductory Econometrics for Finance (4th Ed.), Cambridge University.
- Chan, N.H. (2002): Time Series: Applications to Finance, Wiley.

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MINOR (MI)

MI-7: Survey Sampling and Economic Statistics **Credit 04 (Full Marks: 75)**

MI – 7T: Survey Sampling and Economic Statistics **Credit 03**

Unit 1:

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling. Basic principles of sample survey. Simple random sampling with and without replacement: technique, estimates of population mean, total and proportion, variances of these estimates, estimates of their variances.

Unit 2:

Stratified random sampling: technique, estimates of population mean and total, variances of these estimates, estimates of their variances, proportional and optimum allocations.

Unit 3:

Index Numbers: Construction, Uses, Limitations, Tests for index numbers, Various formulae and their comparisons, Chain Index Number.

Some Important Indices: Consumer Price Index, Wholesale Price Index and Index of Industrial Production - methods of construction.

Unit 4:

Components of time series, Decomposition of time series - Additive and multiplicative model with their merits and demerits, Illustrations of time series.

Measurement of trend by method of free-hand curve, method of fitting mathematical curves by least squares principle, Moving average method.

Determination of seasonal indices by methods of trend ratios and ratios to moving averages.

MI – 7P: Survey Sampling and Economic Statistics Lab **Credit 01**

List of Practical

1. To select an SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square, and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error.
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods.
5. Price & quantity index numbers
6. Tests for index numbers
7. Chain base and fixed base index numbers
8. Cost of living index number
9. Determination of trend by mathematical curve fitting – linear, polynomial, exponential.
10. Determination of trend by moving average method.

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11. Determination of seasonal indices by ratio to trend method.
12. Determination of trend by ratio to moving average method.

Suggested Readings

- Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics, Vol- II, World Press.
- Giri, P.K. & Banerjee, J.: Statistical Tools and Techniques, Academic Publishers
- Bhattacharya, D. & Roychowdhury, S.: Statistics: Theory and Practice, U.N. Dhur & Sons.
- Nagar A.L. & Das R. K. (1976): Basic Statistics
- Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
- Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
- Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.

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