Department of Statistics
Jahangirnagar University, Savar, Dhaka-1342
Syllabus for Professional Masters in Applied Statistics and Data Science (ASDS)
(Valid for 2 Years from the starting date)

The Professional Masters in Applied Statistics and Data Science (ASDS) program fosters at specializing and training in statistical methodology in its theoretical, practical/applied, and in scientific research aspects of modern age, particularly with computer intensiveness.

The courses offered by the department are of compulsory and optional nature. The total credits of courses is 36, totaling 1200 marks, 21 credits of which being compulsory courses and remaining 15 credits being optional courses. Students have the option to choose any available optional courses offered by the department.

For the purposes assessment, 100 marks will be assigned to each 3-credit hours course. The marks distribution is illustrated in the following table. The course teacher will be responsible to evaluate the students taken his/her course.

Description	**Marks (%)**
Class attendance	05
Class performance	05
Assignments, Quiz and class tests	10
Short Report/Presentation	10
Mid-term examination	30
Final examination	40

The Coordination Committee will set and appoint the examiners to evaluate the research projects. The supervisor will be the first examiner and the second examiner should be another faculty member of this program. For the purpose of assessment, 100 marks will be assigned to the project work of 3 credit hours. The first and second examiner will evaluate the report out of 40 marks each. At the time of the defense, faculty member nominated by the Coordination Committee of the program will assess the student out of 20 marks. And finally all the marks will be summarized as total number.

Detailed Syllabus

(a) Non-credits Course

WM-ASDSNC01: Statistical Methods

An overview of Probability and Statistics: Definition, Nature, Scope and Classification of Statistics; it's Relation with other Disciplines, Limitations, uses, Misuses, and Abuses of Statistics.
Processing of Data: Variables and Attributes, Types of Variables, Population and Sample, Different Scales: Cardinal, Ordinal, Interval and Ratio, Source of Data, Classification and Tabulation of Data, Frequency Distribution, Graphical Representation of Data, Stem and Leaf Display, Dot Plot, Time Series Plot.

Measures of Central Tendency: Mean, Median, Mode, Geometric Mean, Harmonic Mean, Application of Measures of Central Tendency.

Measures of Dispersion: Absolute and Relative Measures of Variability, Application of Different Measures of Dispersion, Skewness and Kurtosis.

Simple Correlation and Regression: Bivariate Data, Scatter Diagram, Simple Correlation, Rank Correlation, Simple Linear Regression Analysis.

Contingency Table: Association of Attributes, Coefficient of Association, Total Association, Partial Association.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or MINITAB**.

Texts

1. Allan G. Bluman, (2013): *Elementary Statistics: A Step By Step Approach*, 9th Edition. Mcgraw Hill Inc.

References

1. Lind, A. D., Marchal, W. and Wathen, S. (2017): *Statistical Techniques in Business and Economics*, 17th Edition, Mcgraw Hill Inc.
2. Yule, G. U. and Kendall, M. G. (1999): *An Introduction to the Theory of Statistics*, Universal Book Stall, New Delhi.
3. Newbold, P., Carlson, W. L. and Throne, B. M. (2013): Statistics for Business and Economics, 8th Edition, Pearson Education Ltd.

(b) Compulsory Courses

WM-ASDS01: Probability and Probability Distributions

Basic Concept of Probability: Sample Space, Event, Event Space and Different Types of Events, Classical, Empirical, Relative Frequency, Tree Diagrams and Compound Probability, Conditional Probability, Prior and Posterior Probability, Bayes' Theorem.

Random Variable: Concept of Random Variable, Discrete and Continuous Random Variables, Probability Function, Distribution Function, Function of Random Variable and its Distribution, Joint, Marginal and Conditional Distributions, Independence of Random Variables.
Probability Distribution: Concepts of Bernoulli, Binomial, Poisson, Geometric, Uniform, Exponential and Normal.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or MAPLE**.

Text

1. Ross, S. (2014): *A First Course in Probability*, 9th Edition, Pearson Education Inc.

References

1. Devore, J. L. (2016): *Probability and Statistics for Engineering and the Science*, 9th Edition, Cengage Learning.
2. Mood, A. M., Graybill, F. A. and Boes, D. C. (1974): *Introduction to the Theory of Statistics*, 3rd Edition, Mcgraw-Hill, New York.
3. Hines, W. W., Montgomery, D. C., Goldsman, D. M. and Borror, C. M. (2003): *Probability and Statistics in Engineering*, 4th Edition, Wiley.
4. Krishnamoorthy, K. (2006): *Handbook of Statistical Distributions with Applications*, Chapman and Hall/CRC.

WM-ASDS02: Sampling Methodology

Concept of Sampling: Meaning of Sampling, Importance of Sampling, Data Collection Method, Census and Survey, uses of Sample Survey, Principle Steps in Sample Survey, Advantage of Sampling, and Limitation of Sampling.

Non-probability sampling: Convenience Sampling, Accidental Sampling, Purposive Sampling, Judgment Sampling, Snowballs Sampling, Area Sampling.

Probability Sampling: Simple Random Sampling, Stratified Sampling, Systematic Sampling, Cluster Sampling.

Errors in Survey.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or R**.

Texts

1. Cochran, W. G. (2002): *Sampling Techniques*, 4th Edition, Wiley Eastern, New Delhi.
2. Thompson, S. K. (2012): *Sampling*, 3rd Edition, John Wiley and Sons Inc., New York.

References

1. Lohr, S. L. (2010): *Sampling: Design and Analysis*, 2nd Edition, Brooks/Cole, Cengage Learning.
2. Murthy, M. N. (1977): *Sampling Methods,* 2nd Edition, Statistical Publishing Society, Calcutta.
3. Raj, D. and Chandhok, P. (1998): *Sample Survey Theory,* Narosa Publishing House, New Delhi.
4. Tryfos, P. (1996): *Sampling Methods for Applied Research*, John Wiley and Sons, New York.

WM-ASDS03: Statistical Inference

Point Estimation: Point Estimation and Properties of Good Estimator, Methods of Finding Estimators.

Interval Estimation: Fundamental Notations of Confidence Interval Estimation, Confidence Interval for Mean, proportion and Variance

Test of Hypothesis: Fundamental Notations of Hypothesis Testing, Basic Concepts and Ideas of Test of Significance in Small and Large Samples, Type I and Type II Errors, Level of Significance, P-Vale.

Tests Based on Z, t, F and χ^2 Statistics, Fisher's Exact Test, Analysis and Test Based on $r \times c$ Contingency Table. Different non-parametric tests.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or MINITAB**.

Texts

1. Hogg, R. H., Mckean, J. and Craig, A. T. (2014): *Introduction to Mathematical Statistics*, 7th Edition, Pearson Education Ltd.
2. Mood, A. M., Graybill, F. A. and Bose, D. C. (1974): *Introduction to the Theory of Statistics*, 3rd Edition, Mcgraw-Hill, New York.

References

1. Rohatgi, V. K. and Saleh, A. K. M. E. (2015): *An Introduction to Probability Theory and Mathematical Statistics*, John Wiley and Sons, Inc, New York.

2. Stuart, A., Ord, K. J. and Arnold, S. (1999): *Kendall's Advanced Theory of Statistics*, 6thEdititon, Vol. 2A, Arnold Publishers, London/Oxford University Press, USA.
3. Rohatgi V. K. and Saleh, A. K. M. E. (2001): *An Introduction to Probability and Statistics*, 2nd Edition, John Wiley and Sons Inc., New York.

WM-ASDS04: Introduction to Data Science with Python

Introduction: Definition, Scope of Data Science, Softwares required for Data Science, Introduction of Python.

Descriptive Statistics with Python: Data Preparation, Exploratory Data Analysis, Estimation of different statistics,

Statistical Inference with Python: The Frequentist Approach, Measuring the Variability in Estimates, Point and Interval Estimates, Hypothesis Testing.

Regression Analysis with Python: Linear Regression, Sparse Model, Logistic Regression.

Supervised Learning: Learning Curves, Training, Validation and Test, Generalities Concerning Learning Models, Support Vector Machines, Random Forest.

Unsupervised Learning: Similarity and Distances, Rand Index,Homogeneity, Completeness and V-measure Scores, Silhouette Score, Taxonomies of Clustering Techniques: K-means Clustering, Spectral Clustering, Hierarchical Clustering, Adding Connectivity Constraints, Comparison of Different Hard Partition Clustering Algorithms

Network Analysis: Basic Definitions in Graphs, Social Network Analysis, Centrality, Ego-Networks, Community Detection.

Statistical Natural Language Processing for Sentiment Analysis: Data Cleaning, Text Representation, Bi-Grams and n-Grams.

Assignment and/or a mini project to be completed on the basis of the above topics by **R and or Python.**

Texts

1. Laura Lgual, L. and Seguí, S. (2017): *Introduction to Data Science A Python Approach to Concepts,Techniques and Applications*, Springer, Switzerland.

WM-ASDS05: Research Methodology

Basic Concepts of Research Methodology.

Research Process: Concepts of Decision Making: Certainty, Uncertainty, Ambiguity, Types of Research: Exploratory, Descriptive and Causal Research, Stages in the Research Process, Research Project versus Research Program.

Problem Definition and Research Proposal: The Nature of the Problem, Importance of Problem Definition, Process of Problem Definition, Purpose of Proposal, Types of Research Proposal, Structuring Research Proposal, Evaluation of Research Proposal.

Research Design: Concepts of Research Design, Selection of Appropriate Research Design, Evaluation of Research Design, Types of Research Design: Non-Experimental: Exploratory, Descriptive and Causal Research Designs, Experimental: Pre-Experimental, True-Experimental and Quasi-Experimental Research Designs

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Measurement and Scaling Concept: Concept of Measurement, Purpose of Scaling, Types of Scales, Criteria for Good Measurement: Reliability, Validity and Sensitivity, Difference between Reliability and Validity, Tests for Reliability, Different Measures of Validity.

Data Management and Analysis: Stages of Data Preparation Process, Preliminary Plan of Data Analysis, Questionnaire Checking, Editing, Coding, Re-Coding, Data Cleaning, Statistically Adjusting Data, all Statistical Techniques, Including Modeling and Inference.

Report Preparation and Presentation: Literature Review, Report Writing, Oral Presentation, Research Follow-Up, Reference Writing.

Texts

1. Zikmund, W. G., Babin, B. J., Carr, J. C. and Griffin, M. (2013): *Business Research Methods*, 9th Edition, CengageLearing.

References

1. Malhotra, N. K. (2006): *Marketing Research*, 4th Edition, Pearson Education, Singapore.
2. Babbie, E. (2013): *The Practice of Social Research*, 13th Edition, Cengage Learning.

WM-ASDS06: Multivariate Analysis

Introduction: Meaning and Application of Multivariate Analysis.

Multivariate Normal Distribution: Meaning, Properties and uses of Normal Distribution.

Different Multivariate Sampling Distributions:

Multivariate Multiple Regression: Meaning, Functional form and Underlying Assumptions. Likelihood Ratio Test for Regression Parameters, Predicting Multivariate Multiple Regression.

Principal Components: Introduction to the Principal Components Analysis, Sampling Properties of the Sample Principal Components, Statistical Inference.

Factor Analysis: Definition and Purpose of Factor Analysis, the Mathematical Model for Factor Structure, ML Estimators for Random Orthogonal Factors, Testing the Goodness of Fit of the Factor Model. Factor Interpretation.

Cluster Analysis: Meaning and Objectives of Clustering, Different Similarity Measures, Hierarchical Clustering Method, Non-Hierarchical Method.

Discriminant Analysis: Meaning and Goals of Discriminations and Classification, Fisher's Linear Discriminant Function, Classification Into One of Two and Into One of More than Two Multivariate Populations.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft Excel/SPSS and or SAS/R**.

Text

1. Johnson, R. A. and Wichern, D. W. (2007): *Applied Multivariate Statistical Analysis,* 6th Edition, Pearson Education, Asia.

References

1. Anderson, T. W. (2003): *Introduction to Multivariate Analysis*, 3rd Edition, John Wiley, New York.
2. Izenman, A. J. (2008): *Modern Multivariate Statistical Techniques, Regression, Classification and Manifold Learning*, Springer-Verlag, Newwork.
3. Mardia, K. V., Kent, J. T. andBibby, J. M. (1980): *Multivariate Analysis,* Academic Press, London.
4. Everitt, B. And Hothorn, T. (2011): *AnIntroduction to Applied Multivariate Analysis with R*, 2011th Edition, Springer

WM-ASDS07: Data Analysis Project (3 credit hours)

After successful completion of all required courses, students shall have to submit a research project of 3 credits in partial fulfillment of the requirements for the degree.

(C) Elective Courses

The Master of Professional Studies in Applied Statistics and Data Science offers the following elective courses (from which courses are chosen according to the choice of the option):

WM-ASDS08: Applied Regression Analysis

Simple Linear Model: Linear Model, Regression Function, Simple Linear Regression, Confidence Interval and Test of Hypothesis.

Multiple Regression Model: Partial and Multiple Correlation Coefficient, Confidence Interval of Correlation and Regression Coefficient, Three Variable Regression and its Parameters' Estimation and Hypothesis testing, Properties of OLS Estimators, Dummy Variables Regression, Hypothesis Testing in General Regression Model.

Regression for Binary Data: Logistic Regression, Estimation and Interpretation of Coefficients.
Examination of Residuals: Concepts and Detection of influential observations, different tests.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or SPSS/R**.

Texts

1. Montgomery, D. C. and Peek, E. (2007): *Introduction to Linear Regression Analysis*, 4th Edition, Wiley, New York.

References

1. Gujarati, D. N. (2009): *Basic Econometrics*, 5th Edition, Mcgraw-Hill
2. Chatterjee, S. and Hadi, A. S., (2012): *Regression Analysis by Example*, 5rd Edition, Wiley.
3. Johnston, J. (1997): *Econometric Methods*, 4th Edition, Mcgraw-Hill, New York.

WM-ASDS09: Biostatistics and Epidemiology

Epidemiology:

Basic Concepts: Definition, Scope of Epidemiology, uses of Epidemiology.

Types of Epidemiologic Studies: Cross Sectional, Cohort, Case-Control, Retrospective and Prospective, Clinical Trials, Community Intervention and Cluster Randomized Trials.

Measures of Disease Frequency: Incidence and Prevalence Rates, Relation between Incidence and Prevalence, Case Fatality Rate, Risk Ratio, Rate Ratio, Risk Difference, Rate Difference, Mortality Measures, Standardized Mortality Ratio.

Measures of Association between Disease and Risk Factor: Relative Risk, Attributable Risk, Odds Ratio.

Screening, Properties of Screening Test: Sensitivity, Specificity, Negative and Positive Predictive Values.

Biostatistics

Scope of Biostatistics: Survivor Function, Hazard Function, their Inter Relationships; Censoring and Truncation; Type I, Type II and Random Censoring.

Non-Parametric Methods of Estimating Survivor Functions: Life Table Method, Product Limit Method, Variance Estimates, Cumulative Hazard Function, Plots Involving Estimated Survivor and Hazard Functions.

Inference Procedures for Exponential Distributions: One Parameter Exponential Distribution with Type I and Type II Censored Data, Comparison of Exponential Distributions.

Exponential Regression Model: Method of Estimation, Tests of Hypothesis.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or R.**

Texts

1. Kenneth, J. Rothman, Timothy L Lash and Sander Green Land (2012): *Modern Epidemiology*, 3rd Edition, Lippin Catt.
2. Lawless, J. F. (2003): *Statistical Models and Methods for Life Time Data*, 2nd Edition, Wiley Series, New York.
3. Lee, E. T. and Wang, J. W. (2013): *Statistical Methods for Survival Data Analysis*, 4th Edition, Wiley Series, New York.

References

1. Barker, D. J. P. and Hall, A. J. (1991): *Practical Epidemiology,* Churchil Living Stone, Edinburg.
2. Daniel, W. W. (2000): *Bio-Statistics: A Foundation for Analysis in the Health Science*, 7th Edition, John Wiley and Sons, New York.
3. Khan, A. Q. (1999): *Epidemiology and Disease Control*, 2nd Edition, Dhaka.
4. Newman, S. (2001): *Biostatistical Methods in Epidemiology*, Wiley, New York.
5. Sahai, H. and Khurshid, A. (1995): *Statistics in Epidemiology, Methods, Techniques and Applications*, CRC Press, Boca Raton, Florida.

WM-ASDS10: Time Series Analysis and Forecasting

Overview: Meaning of Time Series, Objectives of Time Series Analysis, Simple Time Series Models, Different components of time series, Estimation and Elimination of Trend and Seasonal Components.

Stationary Processes: Basic Properties, Linear Processes, ARMA Processes, Properties of Sample Mean and Autocorrelation Function. Unit Roots in Time Series Models.

ARMA Models: ARMA (P, Q) Process, ACF and PACF of ARMA (P, Q) Process, Forecasting ARMA Process Problems.

Modeling and Forecasting with ARMA Process: Preliminary Estimation, Diagnostic Checking, Forecasting.

Non-stationary and Seasonal Time Series Models: ARIMA Models for Non-stationary Time Series, Forecasting ARIMA Models, Seasonal ARIMA Models.

Forecasting Technique: Exponential smoothing, Holt-Winters Algorithm.
Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or R.**

Text

1. Brockwell, P. J. and Davis, R. A. (2002): *Introduction to Time Series and Forecasting*, 2nd Edition, Springer, New York.

References

1. Shumway, R. H. and Stoffer, D. S. (2011): *Time Series Analysis and its Applications: with R Examples*, 3rd Edition, Springer.
2. Montgomery, D. C., Jennings, C. L. and Kulahci (2008): *Introduction to Time Series Analysis and Forecasting*, John Wiley and Sons, New Jersy.
3. Diebold, F. X. (2012): *Elements of Forecasting*, 4th Edition, Cengage Learing.
4. Harris, R. and Robert, S. (2003): *Applied Time Series: Modeling and Forecasting*, Replika Press Pvt. Ltd., India.
5. Makridakis, S., Whellwright, S. C. and Hyndman, R. J. (1998): *Forecasting Methods and Applications,* 3rd Edition, John Wiley and Sons, New York.

WM-ASDS11: Environmental Statistics

Basic Idea on Environment: Environment, Concepts of Environment, Basics of Ecology and Ecosystem, Biodiversity, Human Impact on Ecology and Biodiversity, Environment and Sustainable Development, Indispensability, and Inseparability of Sustainable Development, Theory and Practices of Sustainable Development, Greenhouse Gases and Impact of Green House Gases, Ozone Layer.

Health Environment: Sources of Health Risk in Air, Water, Food, and Wastes, Climate Change and Environmental Health, Arsenic Instigation in Drinking Water.

Environmental Monitoring: Network Sampling, Composite Sampling, Ranked-Set Sampling, Delectability, Constant Dilectability Over Region, Estimating Delectability, Effect of Estimated Delectability, Detetectability with Simple Random Sampling.

Environmental Pollutants: Environmental Pollutants, Impacts of Pollutants on Environment, Sources of Environmental Pollutants, Decomposition of Pollutants, Types of Environmental Pollution.

Diffusion and Dispersion of Pollutants: Concept of Diffusion and Dispersion of Pollutants, Distribution of Pollutants with Respect to Space and Time by Wedge Machine, Plume Model.

Dilution of Pollutants: Deterministic Dilution, Stochastic Dilution, Theory of Successive Random Dilution (SRD), Application of SRD to Environmental Phenomena: Air Quality, Indoor Air Quality, Water Quality, Concentrations of Pollutants in Soils, Plants and Animals.

Texts

1. Wayne, R. Ott. (1995): *Environmental Statistics and Data Analysis,* Lewis Publishers, England.

References

1. Barnett, V. and Turkman, K. F. (1993): *Statistics for the Environment,* John Wiley and Sons, Chichester.
2. Hill, M. K. (2012): *Understanding Environmental Pollutions*, 3rd Edition, Combridge University Press, London.
3. Barnett, V. (2004): *Environmental Statistics: Methods and Applications*, John Wiley and Sons, New York.

WM-ASDS12: Demographic Method and Population Analysis

Introduction: Demography and Population Studies, Relationship between Demography and Other Disciplines, Glossary of Population Research Terms, Aims and Objectives of Population Studies, Important Characteristics of Demography.

Age and Sex Composition: Age and Sex Composition and their Importance.

Demographic Data: Sources of Demographic Data, Methods of Demographic Data Collection, Sources of Type of Errors in Demographic Data and their Correlations.

Fertility and Fecundity: Detail Study of Fertility, Fecundity, Various Measures of Fertility, Important Determinants of Fertility, Estimation of Mean Age at Childbearing.

Mortality and Morbidity: Concept of Mortality and Morbidity, Important Determinants of Mortality, Various Measures of Mortality and Morbidity.

Life Table: Life Table and its uses, Current and Cohort Life Table, Construction of Life Table.

Demographic Transition Theory, Population Policies, Population Projection.

Urbanization and Migration: Economic and Social Consequences of Rapid Urbanization and Migration with Respect to Bangladesh.

Text

1. Shryock, H. S. (1976): The Methods and Materials of Demography, Academic Press, New York.
2. Swanson D. A. andJacob S. Siegel, J. S. (2004): *The Methods and Materials of Demography*, Second Edition2nd ed. Edition, Emerald Group Publishing.

Reference:

1. Yusuf F., Jo. M. Martins, Swanson, D. A. (2014): *Methods of Demographic Analysis*, 2014th Edition, Springer.
2. Rowland, D. T. (2003): *Demographic Methods and Concepts*,PAP/CDR Edition, Oxford University Press.
3. Samuel Preston, Patrick Heuveline, Michel Guillot, (2000): *Demography: Measuring and Modeling Population Processes*,1st Edition, Wiley-Blackwell.
4. Andrew Hinde, A. (1998): *Demographic Methods*, 1st Edition, Hodder Arnold Publication, Routledge.

WM-ASDS13: Economic and Official Statistics

Economic Statistics:

Overall Economic Situation: Major Macroeconomic Problems–(Inflation, Unemployment and Low Growth Rate). Macroeconomic Policy and Goals. Unemployment and Inflation.

Role of Government and Fiscal Policy: Objectives and Instruments of Fiscal Policy. Budget, Sources of Revenue, Direct and Indirect Taxes.

Working of Monetary and Fiscal Policy: Monetary and Fiscal Policy in a Closed Economy, Open Economy, Determination of Interest Rate, Exchange Rate Determination. Monetary and Fiscal Policy in an Open Economy.

Inflation: Causes of Inflation, Cost Push and Demand Pull Inflation, Stagflation, Demand and Supply Side Factors of Inflation.

Income Distribution: Law of Income and Wealth Distribution, Income Inequality, Sources of Income Inequality, the Effect of Inequality on Economic Growth and Productivity, Two Popular Income Distributions: Pareto Distribution and Lognormal Distribution.

Poverty, Inequality, and Development: Measuring Inequality and Poverty - Size Distribution, Lorenz Curves, Gini Coefficient, Poverty Gap.

Official Statistics:

Official Statistics of Bangladesh Especially Related to Sectors of Economy and Population; Statistical Data Sources, Data Collection and Dissemination; Problems Associated with Administrative Data, Major Obstacles/Weakness in using Administrative Data for Statistical Purpose.

Publications of Different Sources of Official Data: Bangladesh Bank, Ministry of Finance, Bangladesh Bureau of Statistics etc., Board of Investment (BOI) of Bangladesh, Climate Change Cell, Export Promotion Bureau, Bangladesh Export Statistics. Asian Development Bank (ADB), the International Food Policy Research Institute (IFPRI), the International Labour Organization (ILO), the International Monetary Fund (IMF), and the World Bank.

Text

1. Mankiw, N. G. (2014), *Principles of Macroeconomics*, Cengage Learning.
2. Gupta, S. C. and Kapoor, V. K. (2014), *Fundamentals of Applied Statistics,* Sultan Chand and Sons, New Delhi.

References

1. M. Parkin (2015): *Macroeconomics*, 12th Edition, Pearson.
2. J. E. Stiglitz (1997): *Principles of Macroeconomics*, 2nd Edition, Norton and Company, Inc.
3. N. G. Mankiw (1997): *Macroeconomics*, 3rd Edition, Worth Publishers.
4. P. A. Samuelson and W. D. Nordhaus: *Economics*, 17th Edition.

WM-ASDS14: Actuarial Statistics

Basic Concept: Definition of Actuarial Science, its Relationship with Life Insurance, Important uses of Actuarial Statistics Especially in Context of Bangladesh.

Interest: Theory of Rates of Interest and Discount Including Theoretical Continuous Case of Forces of Interest and Discount,

Amortization and Sinking Funds, and Bonds: Amortization and Amortization Schedule, Sinking Funds Yield Rates, Annuities and Sinking Funds Including Continuous Case, Practical and Theoretical Applications Primarily to Mortgages and Bonds, Yield Rates.

Annuities: Meaning, Perpetuities, Continuous and Varying Annuities.

Survival Distributions, Life Tables, Life Insurance, Life Annuities, Net Premium, Premium Series, Multiple Life Functions, Multiple Decrement Models, Valuation Theory for Pension Plans, Expense Function and Dividends.

Text

1. Parmenter, M. M. (1999): *Theory of Interest and Life Contingencies with Pension Application,* 3rd Edition, ACTEX Publication, Winsted, CT, USA.

References

1. Tze Leung Lai and Haipeng Xing, (2008): *Statistical Models and Methods for Financial Markets*, Springer Verlag.
2. Ayres, F. Jr., (1963): *Theory and Problems of Mathematics of Finance,* Schaum's Publishing Co., New York.
3. Kellison, S. G. (2009): *Theory of Interest*, 3rd Edition, Mcgraw-Hill/Irwin.
4. Bowers, N. L., Gerber, H. V., Hickman, J. C., Jones, D.A. and Nesbitt, C. J. (1978): *Actuarial Mathematics*, 2nd Edition, Society of Actuaries, Chicago.

WM-ASDS15: Applied Econometrics

Basic Concept of Econometrics: Meaning, Methodology of Econometrics, Types of Econometrics, Nature and Source of Data for Econometric Analysis.

Multicollinearity: Nature of Multicollinearity, Practical Consequences of Multicollinearity, Detection and Remedy of Multicollinearity.
Heteroscedasticity: Meaning and Nature of Heteroscedasticity, Consequences of Using Ordinary Least Squares in Presence of Heteroscedasticity, Detection and Remedial Measures of Heteroscedasticity.

Autocorrelation (Serial Correlation): Meaning and Nature, Consequences of Using Ordinary Least Squares in Presence of Autocorrelation, Detection of Autocorrelation. Remedial Measures of Autocorrelation.
Model Selection: Leamer's and Hendry's Approach to Model Selection, Non-Nested Hypothesis Test by (I) Discrimination Approach (Ii) Discerning Approach and (Iii) Other Criteria.

Dynamic Econometric Model: Autoregression, Distributed Lagged Variables, Lag Model, Meaning of Dynamic Distribution Lag and Autoregressive Models, Role and Reasons for Lags in Econometric Model. Detecting Autocorrelation in Autoregressive Model.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or STATA/R.**

Texts

1. Gujarati, D. N. and Poter, D. (2008): *Basic Econometrics*, 5th Edition, Mcgraw-Hill, New York.
2. Wooldridge, J. M. (2016), Introductory Econometrics: A Modern Approach, 6th Edition, Cengage Learning, South-Western.

References

1. Judge, G. G. Hill, R. C., Griffiths, W. E., Lütkepohl, H. and Lee, T. C. (1988): *Introduction to the Theory and Practice Of Econometrics*, 2nd Edition, John Wiley and Sons, New York.
2. Cameron, A. C. and Trivedi, P.K. (2005): *Microeconometircs- Methdos and Application*, Cambridge University Press, UK
3. Johnston, J. and Dinardo, J. (1997): *Econometric Methods*, 4th Edition, Mcgraw-Hill, New York.

WM-ASDS16: Quality Control & Operation Research

Quality Control

Basic Principles of Quality Control: Meaning of Quality, Quality Improvement, Statistical Methods for Quality Control and Improvement.

Methods and Philosophy of SPC: Causes of Variation, Statistical Basis of the Control Chart, Choice of Control Limits, Analysis of Patterns on Control Charts etc., Implementation and Application of SPC.

Control Charts for Variables: $\bar{X}, R$ and S, the Effect of Non Normality on $\bar{X}, R$ Charts, OC Function, the average Run Length for the $\bar{X}$ Chart, Applications of these Charts. Control Charts for Attributes.
Acceptance Sampling: Guidelines of using Acceptance Sampling.

Single Sampling Plan: Designing of the Plan, the OC Curve, Rectifying Inspection etc.

Operation Research
Basic Concept of Operation Research: Definition, Characteristics, Scope and Limitations of Operational Research, Problem Formulation and Modeling in Operational Research, Important Characteristics of Operational Research Techniques.

Linear Programming: Introduction, Statement of the General Linear Programming Problem, Mathematical Formulation of Linear Programming Problem.

Concepts of Game Theory and applications.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or MINITAB/SPSS.**

Text

1. Montgomery, D. C. (2008): *Introduction to Statistical Quality Control*, 6th Edition, John Wiley and Sons, New York.
2. Taha, H. A. (2011): *Operations Research: An Introduction*, 9th Edition, Prentice-Hall: New Delhi.

References

1. Banks, J. (1989): *Principles of Quality Control*, John Wiley and Sons, New York.
2. Burr, J. (2004): *Elementary Statistical Quality Control*, CRC Press.
3. Gass, S. I. (1985): *Linear Programming Methods and Applications,* 5th Edition*,* Mcgraw-Hill Ltd., New York.
4. Hadley, G. (1994): *Linear Programming*, Narosa Publishing House, New Delhi.

WM-ASDS17: Analysis of Variance & Experimental Design

Analysis of Variance in One-Way, Two-Way and Three-Way Classification.

Basic Principles in Experimental Design, Completely Randomized Design, Randomized Block Design, Latin Square Design, Efficiency of Designs.

Covariance Analysis in Completely Randomized Design, Randomized Block Design, Latin Square Design with Two Concomitant Variance.

Covariance Analysis with one and two Concomitant Variables.

Assignment and/or a mini project to be completed on the basis of the above topics by **Microsoft-Excel and or R.**

Texts

1. Montogomery, D. C. (2012): *Design and Analysis of Experiments,* 8th Edition, Wiley, USA.

References

1. Cochran, W. G. and Cox, G. M. (2000): *Experimental Designs*, 2nd Edition, John Wiley, New Delhi.
2. Das, M. N. and Giri, N. C. (1997): *Design and Analysis of Experiment*s, 2nd Edition, New Age International (P) Ltd., India.

WM-ASDS18: Data Mining

Overview: Meaning of Data Mining and Knowledge Discovery, Data Mining Tasks, Sequence Discovery, Development of Data Mining, Data Mining Issues and Mining Metrics, Social Implications of Data Mining.

Data Mining Techniques: Statistical Perspective on Data Mining, Models Based on Summarization, Bayes Theorem, Hypothesis Testing. Similarity Measures, Decision Tree.

Neural Network: Background, Learning, Basic Neuron Model, Perception, Multiplayer Perception.

Classification: Issues in Classification, Statistical-Based Algorithms, Regression, Bayesian Classification, Distance-Based Algorithms.

Clustering: Similarity and Distance Measures, Hierarchical Algorithms, Agglomerative Algorithms, Divisive Clustering, K-Means Clustering.

Association Rules: Meaning of Association, Large Item Sets, Basic Algorithms, Apriori Algorithm.

Assignment and/or a mini project to be completed on the basis of the above topics by **SPSS and or SAS/R.**

Texts

1. Dunham, M. H. (2003): *Data Mining: Introductory and Advanced Topics,* 1st Edition*,* Pearson.
2. Ibrahim, A. M. (2004): *Fuzzy Logic for Embedded Systems Applications*, Elsevier Science, USA.

References

1. Larose, D. T. (2006): *Data Mining: Methods and Models*, Wiley-Interscience, India.
2. Schalkoff, R. (2005): *Pattern Recognition Statistical, Structural and Neural Approaches*, John Wiley and Sons, New York.

WM-ASDS19: Big Data

Introduction of Big Data: Dawn of the Big Data Era, Definition and Features of Big Data, Big Data Value, the Development of Big Data, Challenges of Big Data.

Big Data Related Technologies: Cloud Computing, Relationship between Cloud Computing and Iot, Relationship between Iot and Big Data, Data Center.

Data Collection, Sampling and Preprocessing: Types of Data Sources, Sampling, Types of Data Elements, Big Data Generation, Enterprise Data, Iot Data, Internet Data, Bio-Medical Data, Data Collection, Data Transportation, Data Pre-Processing, Visual Data Exploration and Exploratory Statistical Analysis.

Big Data Storage: Storage System for Massive Data, Distributed Storage System, Storage Mechanism for Big Data, Database Technology, Design Factors, Database Programming Model.

Big Data Processing Algorithms: Multi-Core Versus Distributed Systems, Distributed Algorithms, Distributed Hash Tables, Bulk Synchronous Parallel (Bsp), Mapreduce Paradigm, Input Reader and output Writers, Putting all Together.

Big Data Search and Mining: Big Data Search and Retrieval, K-Means Clustering, Social Network Clustering—Topology Discovery, Clustering Algorithm to find Network Topologies, Social Network Condensation, Text Sentiment Mining, Big Data Mining and Analysis Tools.

Big Data Applications: Structured Data Analysis, Text Data Analysis, Web Data Analysis, Multimedia Data Analysis, Network Data Analysis, Mobile Traffic Analysis, Application of Big Data in Enterprises, Application of Online Social Network-Oriented Big Data, Applications of Healthcare and Medical Big Data.

Assignment and/or a mini project to be completed on the basis of the above topics by **SPSS and or SAS/R.**

Texts

1. Min Chen, Shiwen Mao, Yin Zhang and Victor C.M. Leung, (2014), *Big Data: Related Technologies, Challenges and Future Prospects*, Springer.
2. HrushikeshaMohanty, PrachetBhuyan and Deepak Chenthati, (2015), *Big Data a Primer*, Springer.
3. Bart Baesens, (2014), *Analytics in a Big Data World: The Essential Guide to Data Science and its Applications,* Wiley

Reference

1. Zikopoulos, P.C., Eaton, C., Deroos, D., Deutsch, T. and Lapis, G., (2012), *Understanding Big Data*, Mcgrawhill, New York.

WM-ASDS20: Bioinformatics

Introduction: Basic Cell Architecture, the Structure, Content and Scale of Deoxyribonucleic Acid (DNA), History of the Human Genome, Genes and Proteins.

Introduction and Bioinformatics Resources: Knowledge of Various Databases and Bioinformatics Tools Available at These Resources, the Major Content of the Databases, Nucleic Acid Sequence Databases (Genbank, EMBL, DDBJ), Protein Sequence Databases(SWISS-PROT, Trembl, PIR, PDB), Genome Databases (NCBI, EBI, TIGR, SANGER).

Sequence Analysis: Various File Formats for Bio-Molecular Sequences: Genbank, Fasta, Gcg, Msf, Nbrf-Pir Etc., Basic Concepts of Sequence Similarity, Identity and Homology, BLAST and FASTA Algorithms, Various Versions of Basic BLAST and FASTA.

Pairwise and Multiple Sequence Alignments: Basic Concepts of Sequence Alignment, Needleman and Wuncsh, Smith and Waterman Algorithms for Pairwise Alignments, Progressive and Hierarchical Algorithms for MSA.

Machine Learning and Bioinformatics: Introduction to Various Machine Learning Techniques and their Applications in Bioinformatics. Genetic Algorithms, Support Vector Machine, Neural Networks.

Texts

1. Edward KeedwellandAjit Narayanan, (2005), *Intelligent Bioinformatics: The Application of Artificial Intelligence Techniques to Bioinformatics Problems*, John Wiley and Sons Ltd.

2. Warren Ewens and Gregory Grant, (2005), *Statistical Methods in Bioinformatics: An Introduction*, 2nd Edition, Springer
3. Jin Xiong, (2006), *Essential Bioinformatics*, Cambridge University Press.

References

1. Lesk, A., (2014), *Introduction to Bioinformatics*, 4th Edition, Oxford University Press.
2. Baxevanis, A. D., and B. F. Ouellette, (2004), *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (Vol. 43), John Wiley and Sons.
3. Mathur, S. K., (2010), *Statistical Bioinformatics: with R,* Academic Press.
4. Devid W. Mount, (2004), *Bioinformatics: Sequence and Genome Analysis*, Second Edition, Cold Spring Harbor Laboratory Press.
5. R. C. Rastogi, (2009), *Bioinformatics: Concepts, Skills and Applications*, Second Edition, CBS Publishers and Distributions.

WM-ASDS21: Categorical Data Analysis

Contingency Tables and Inference for Two-Way Contingency Tables: Probability Structure for Contingency Tables, Comparing Two Proportions, Measuring Association in $I \times J$ Tables. Confidence Interval for Association Parameters, Testing Independence in Two-Way Contingency Tables.
Generalized Linear Model: Generalized Linear Model, Generalized Linear Models for Binary Data and Counts, Model Checking.

Logistic Regression-Building and Applying: Interpreting Parameters in Logistic Regression, Inference for Logistic Regression, Logistic Models with Categorical Predictors, Multiple Logistic Regression.

Models for Multinomial Responses: Baseline-Category Logit Models, Cumulative Logit Models, Cumulative Link Models.

Clustered Categorical Data- Marginal and Transitional Models: Marginal Modeling: Maximum Likelihood Approach, Generalized Estimating Equations Approach.

Assignment and/or a mini project to be completed on the basis of the above topics by **SPSS and or SAS/R.**

Text

1. Agresti, A. (2012): *Categorical Data Analysis*, 3nd Edition, John Wiley and Sons, New York.

Reference

1. Powers, D. A. and Xie, Yu. (2008): *Statistical Methods for Categorical Data Analysis,* 2nd Edition, Emerald Group Publishing Ltd., London.

WM-ASDS22: Machine Learning for Data Science

Machine Learning Overview: Types, Use and Process of Machine Learning, Mathematics behind Machine Learning.
Topics will include least squares methods, Gaussian distributions, linear classification, linear regression, maximum likelihood, exponential family distributions, Bayesian networks, Bayesian inference, mixture models, the EM algorithm, graphical models, hidden Markov models, support vector machines, and kernel methods. Part of the course will be focused on methods and problems relevant to big data problems.

Assignment and/or a mini project to be completed on the basis of the above topics by **SPSS and or SAS/R.**

Text:

1. Daniel D. Gutierrez, (2015): *Machine Learning and Data Science: An Introduction to Statistical Learning Methods with R*, 1st Edition, Technics Publications.
2. John Paul Mueller and Luca Massaron (2016)*: Machine Learning For Dummies,* 1st Edition, For Dummies*.*