Curriculum
for
M.S. in Statistics

Statistics Discipline
Khulna University, Khulna - 9208
Bangladesh

March 2017

Marks distribution for theory courses:

Attendance	10%
Continuous assessment	30%
Written exam	60%

Marks distribution for sessional courses:

Attendance	10%
Viva	30%
Continuous assessment	60%

- **Thesis/Project evaluation:**

Thesis/Project Report	80%
Defense / Oral examination	20%

- **Bases for class attendance marks (both for theory and sessional):**

Attendance/ Participation	**Marks**
90% and above	10
85% to less than 90%	9
80% to less than 85%	8
75% to less than 80%	7
70% to less than 75%	6
65% to less than 70%	5
60% to less than 65%	4
Less than 60%	0

- **Continuous assessment:**
  There will be at least 03 (three) class tests (written exams)/ Quizzes/ Spot tests/ Open book exams/ Presentations/ Assignments/ Home works, etc.

- **Grading system and grading scale:**

% of Marks	**Letter Grade**	**Grade Point**
80% or above	A+ (A plus)	4.00
75% to less than 80%	A (A regular)	3.75
70% to less than 75%	A- (A minus)	3.50
65% to less than 70%	B+ (B plus)	3.25
60% to less than 65%	B (B regular)	3.00
55% to less than 60%	B- (B minus)	2.75
50% to less than 45%	C+ (C plus)	2.50
45% to less than 50%	C (C regular)	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00
	S	Satisfactory
	U	Unsatisfactory
	I	Incomplete

- **Assessment tools:**
  Theory courses:
    - Class participation (Example: attendance)
    - Continuous assessment (examples: Quiz, spot test, open book exam, presentation, assignments, written exams etc.)
    - Term final examination (written test)

  Sessional courses:
    - Class participation (Example: attendance)
    - Sessional assessment (examples: field work, lab work, case study, performance, spot test, open book exam, presentation, assignments, written exams etc.)
    - Viva-voce (oral)

  Thesis/ Project:

- Participation (Example: Contact/Discussion/Communication with the supervisor)
- Evaluation (examples: report, project paper, monograph etc.)
- Viva-voce (oral)

8. Course structure:

Program duration: 1Year
Number of terms: 2 (Two)
Term duration: 18 Weeks (Class: 13 weeks + Preparatory leave& Examination: 5 weeks)
Total number of credit available: 81
Minimum credit to be earned: 36

8.1 Summary of the total availablecredits (core and optional) from different areasof study

- **Distributions of credits in different areas of study:**

Areas of Study	Theory		Sessional/Thesis/Project		Total		Total
	Core	Optional	Core	Optional	Core	Optional	
Data Mining	0.0	12.0	0.0	0.0	0.0	12.0	12.0
Biostatistics &Bioinformatics	0.0	15.0	0.0	0.0	0.0	15.0	15.0
Demography	0.0	6.0	0.0	0.0	0.0	6.0	6.0
Inference	9.0	9.0	0.0	0.0	9.0	9.0	18.0
Sampling	0.0	3.0	0.0	0.0	0.0	3.0	3.0
Time series & Stochastic Process	3.0	3.0	0.0	0.0	3.0	3.0	6.0
Public health	0.0	3.0	0.0	0.0	0.0	3.0	3.0
EnvironmentalStudies	0.0	3.0	0.0	0.0	0.0	3.0	3.0
Thesis	0.0	0.0	9.0	0.0	9.0	0.0	9.0
Project	0.0	0.0	4.0	0.0	4.0	0.0	4.0
Statistical Computing	0.0	0.0	2.0	0.0	2.0	0.0	2.0
Total	12.0	54.0	15.00	0.0	27.0	54.0	**81.0**

- **Term-wise distribution of credits:**

Term	Group	Theory		Sessional/Thesis/Project		Total Credit Hrs.
		Core	Optional	Core	Optional	
First	Thesis	6.0	9.0	3.0	0.0	18.0
	Non-thesis	6.0	9.0	3.0	0.0	18.0
Second	Thesis	6.0	6.0	6.0	0.0	18.0
	Non-thesis	6.0	9.0	3.0	0.0	18.0
Total		12.0/12.0	15.0/18.0	9.0/6.0	0.0/0.0	**36.0**

8.2 Course outline:

(a) For Thesis Group

Year-1 Term-1			
Course No	**Course Title**	**Hrs/Week**	**Credit Hours**
Stat-5100	Thesis	0-6	3.00
Stat-5101	Generalized Linear Model	3-0	3.00
Stat-5103	Applied Multivariate Analysis	3-0	3.00
Optional-I*		3-0	3.00
Optional-II*		3-0	3.00
Optional-III*		3-0	3.00
Total		**15-6**	**18.00**
* **Optional Courses:** Three optional courses should be selected from the following courses.			
Stat-5105	Population and Social Development	3-0	3.00
Stat-5107	Statistical Methods for Reliability Data	3-0	3.00
Stat-5109	Advanced Biostatistics	3-0	3.00
Stat-5111	Bayesian Statistics	3-0	3.00

Stat-5113	Advanced Meta Analysis	3-0	3.00
Stat-5115	Time Series and Financial Econometrics	3-0	3.00
Stat-5117	Bioinformatics	3-0	3.00
Stat-5119	Sample Survey Design	3-0	3.00
Stat-5121	Categorical Data Analysis	3-0	3.00

Year-1 Term-2			
Course No	**Course Title**	**Hrs/Week**	**Credit Hours**
Stat-5200	Thesis	0-12	6.00
Stat-5201	Advanced Stochastic Process	3-0	3.00
Stat-5203	Advanced Statistical Inference	3-0	3.00
Optional-I*		3-0	3.00
Optional-II*		3-0	3.00
Total		**12-12**	**18.00**
* **Optional Courses:** Two optional courses should be selected from the following courses.			
Stat-5205	Statistical Signal Processing	3-0	3.00
Stat-5207	Machine Learning	3-0	3.00
Stat-5209	Statistical Methods for Artificial Intelligence	3-0	3.00
Stat-5211	Advanced Data Mining	3-0	3.00
Stat-5213	Advanced Bioinformatics	3-0	3.00
Stat-5215	Mathematical Demography	3-0	3.00
Stat-5217	Advanced Environmental Statistics	3-0	3.00
Stat-5219	Health Studies	3-0	3.00
Stat-5221	Optimum Experimental Designs	3-0	3.00

(b) For Non-thesis Group

Year-1 Term-1			
Course No	**Course Title**	**Hrs/Week**	**CreditHours**
Stat-5101	Generalized Linear Model	3-0	3.00
Stat-5103	Applied Multivariate Analysis	3-0	3.00
Optional-I*		3-0	3.00
Optional-II*		3-0	3.00
Optional-III*		3-0	3.00
Stat-5130	Project	0-4	2.00
Stat-5140	Statistical Computing-I	0-2	1.00
Total		**15-6**	**18.00**
* **Optional Courses:** Three optional courses should be selected from the following courses.			
Stat-5105	Population Studies	3-0	3.00
Stat-5107	Statistical Methods for Reliability Data	3-0	3.00
Stat-5109	Advanced Biostatistics	3-0	3.00
Stat-5111	Bayesian Statistics	3-0	3.00
Stat-5113	Advanced Meta Analysis	3-0	3.00
Stat-5115	Time Series and Econometric	3-0	3.00
Stat-5117	Bioinformatics	3-0	3.00
Stat-5119	Sample Survey Design	3-0	3.00
Stat-5121	Categorical Data Analysis	3-0	3.00

Year-1 Term-2			
Course No	**Course Title**	**Hrs/Week**	**CreditHours**
Stat-5201	Advanced Stochastic Process	3-0	3.00
Stat-5203	Advanced Statistical Inference	3-0	3.00
Optional-I*		3-0	3.00
Optional-II*		3-0	3.00
Optional-III*		3-0	3.00
Stat-5230	Project	0-4	2.00
Stat-5240	Statistical Computing-II	0-2	1.00
Total		**12-12**	**18.00**
* **Optional Courses:** Three optional courses should be selected from the following courses.			
Stat-5205	Statistical Signal Processing	3-0	3.00
Stat-5207	Machine Learning	3-0	3.00
Stat-5209	Statistical Methods for Artificial Intelligence	3-0	3.00
Stat-5211	Advanced Data Mining	3-0	3.00
Stat-5213	Advanced Bioinformatics	3-0	3.00
Stat-5215	Mathematical Demography	3-0	3.00
Stat-5217	Advanced Environmental Statistics	3-0	3.00
Stat-5219	Health Studies	3-0	3.00
Stat-5221	Optimum Experimental Designs	3-0	3.00

8.3 Course profile:

Year-1 Term-1
(For Thesis and Non-thesis Groups)

Course No: Stat-5100	**Course Title:** Thesis	**Credit Hours:** 3.00
Rationale: This is a research based comprehensive computing and prerequisite course for the course 'Stat-5200: Thesis' conducted by the thesis supervisor(s)to provide research based knowledge and produce a substantial piece of work.		
Course Objectives: ▪ Develop student's research curiosity, computing capability and skills in critical and creative thinking, which will be enriched their data analysis ability.		
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to 1. Find out the own area of interest and explore in depth. 2. Identify own question and think critical way to solve problems. 3. Develop and demonstrate analytical, judgmental, computation, presentation and communication skills. 4. Apply their communication and computation skills in real life problems.		
Course Content:		
The respective supervisor will prescribe the contents and help the selected student(s) to enhance the computing and research capability.		

Course No: Stat-5101	**Course Title:** Generalized Linear Model	**Credit Hours:** 3.00
Rationale: This course is designed to tackle the problems that go beyond the frame of linear models.		
Course Objectives: ▪ Deal with the nature of the data and the concepts of the models going beyond the conventional linear form ▪ Model with nominal, ordinal andcount response.		
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to 1. Recognize and understand the nature of the additional structure of problems for which statistical techniques met earlier in the study programme are insufficient. 2. Develop functional knowledge of modelling techniques that are appropriate for problems related to exponential family. 3. Identify the research problems in public health that can be answered with the aid of generalized linear models 4. Interpret and present findings to real data using appropriate generalized linear models		
Course Content:		
Section – A	**Section – B**	
Generalized linear models: exponential family of distributions; Estimation: method of maximum likelihood, method of least squares, estimation of generalized linear models, quasi- likelihood procedure, penalized likelihood procedure etc. Inference: sampling distribution of scores, sampling distribution of maximum likelihood estimators, Confidence intervals for model parameters, adequacy	Models for binary responses: probability distributions, generalized linear models, dose response models, general logistic regression, maximum likelihood estimation and log-likelihood ratio statistic, other criteria for goodness of test, least square methods; Multinomial distributions; Nominal logistic regression models; Ordinal logistic regression models; Models for count Data: probability distributions, log-linear	

of a model, sampling distribution for log-likelihood statistic, log-likelihood ratio statistic (deviance), assessing goodness of test, hypothesis testing.	models, maximum likelihood estimation, hypothesis testing and goodness of test.

Course No:Stat-5103	**Course Title: Applied Multivariate Analysis**	**Credit Hours: 3.00**

Rationale: This course is planned to continue higher Multivariate Analysis and co-integrated with reviewing undergraduate Advanced Multivariate Analysis.

Course objectives:

- Indulgent concepts of Multivariate Normal distribution and Multivariate Linear Regression Models.
- Understanding Advanced Multivariate Methods likeLISERL l, covariance structure, model fitting strategy, Multidimensional scaling, correspondence analysis, Path analysis.
- Appreciative knowledge about PCA, Factor Analysis, Discrimination and Classification.
- Ability to apply clustering methods and understand correspondence analysis, Cluster Analysis.
- Develop skill of entropy, mutual information etc. to realize independent component theory.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Assessing Box-Cox transformation, detecting and clearing outliers.
2. Infer about Mean Vector, Confidence Region and Conferring Methods of multiple comparisons.
3. Demonstrate profile analysis, repeated measure designs and growth models.
4. Monitor quality with principle components, LISERL model, Multidimensional scaling, correspondence analysis, Path analysis.
5. Realize PCA, Factor Analysis, Discrimination and Classification and its implementation in economic sector and artificial world.
6. Identify the necessarily of Independent Component Analysis

Course Content:

Section – A	**Section – B**
Review of Multivariate Normal distribution- Assessing assumptions of multivariate normality by Box-Cox transformation, detecting and clearing outliers, multivariate normal observations to near multivariate normal, Inference about Mean Vector, Confidence Region and Conferring Methods of multiple comparisons, two way multivariate analysis of variance, Profile analysis, Repeated measure designs and growth models, perspective and a strategy for analyzing multivariate models. Review of PCA, Factor Analysis, Discrimination and Classification,Cluster Analysis and Independent Component Analysis.	**Multivariate Linear Regression Models-** Likelihood ratio tests for regression parameters, other multivariate test statistics, predictions from multiple regression, concept of linear regression for prediction of several variable, partial correlation coefficients, mean correction from of the regression model, relating formulations, multiple regression models with time dependent errors. **Advanced Multivariate Methods-** Monitoring quality with principle components, LISERL model, construction of a path diagram, covariance structure, model fitting strategy, Multidimensional scaling, correspondence analysis, Path analysis.

Course No: Stat-5105	**Course Title:** Population and Social Development	**Credit Hours:** 3.00

Rationale: This course is designed to provide **a clear and advanced** statistical knowledge**of a p**opulation issues have implications for the environment, employment, families, health, urbanization, migration, security in old age and refugee movements.

Course Objectives:

- Characterize domestic violence in Bangladesh.
- Clarify the population based on its aging index.
- Identify social indicators to prosperous a society, country and nation.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

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

1. Identify the reasons of domestic violence.

2. Categorize domestic violence in a nation.
3. Criticize human development indicators.
4. Measure the millennium development goals and current situation of Bangladesh.
5. Point out population aging index and aging policy in Bangladesh.
6. Counsel about advocacy, importance of advocacy and monitoring & evaluating.
7. Outline megacity, urban projection, estimating megacity population.
8. Design about population stabilization, tempo effect, implication of population stabilization.
9. Explain about disability adjustment life year, principle and philosophy of DALY, measurement of DALY
10. Construction of life table of disability prevalence and concern its own future.
11. Policy makers or planners pay serious attention to population trends, their causes and effects.

Course Content:

Section – A	**Section – B**
Gender Based Domestic Violence (GBDV): Reasons of Domestic Violence, Types of Physical Violence, Social-Economic and Reproductive Health Implication of GBDV, Important Steps in Reproducing Gender Based Domestic Violence. **Social Development Indicator**: Human capital indicators, population policy, social capital development/social capital, gender and development, social protection/social network. **Millennium Development Goal (MDG)& Sustainable Development Goal (SDG):** MDG Attainments and its extensions**.** SDG goals and Target with respect to Bangladesh **Population Aging**: Elderly situation, aging index, support ratio index, care index, elderly situation in Bangladesh, components of aging policy in Bangladesh, Goals and objectives of aging policy in Bangladesh. **Gender Preference**: Family size, ideal family size, sex preference of family size, factors affecting sex preference in Bangladesh, relationship between actual fertility and ideal fertility, fertility of spacers and limiters and their effect, effect of under-five mortality or infant mortality on desired family size.	**Urbanization**: Megacity, urban projection, estimating megacity population and implications on basic needs, social economic and demographic implications. **Gompertz Model**: Assumption, estimation process, advantages and disadvantages, derivation of model parameters. **Population Stabilization**: Population stabilization, tempo effect, implication of population stabilization if replacement fertility is not achieve, population momentum, reduction of population momentum, factors to be considered in reduction population momentum. **Disability Adjusted Life Years (DALY)**: Necessity of meaning DALY, concepts, principle and philosophy of DALY, measurement of DALY, construction of life table of disability prevalence, problems in DALY. **Poverty:** conceptual issues of poverty; measurement of different poverty indices social inequality. Development in agriculture, industry (a) growth performance, outlay and yield (b) agrarian structure and its changes (c) plan outlay; rural development; human development; women and youth development; land reforms in Bangladesh; infrastructure development; ADP allocation to social sectors; fiscal policies for development.

Course No: Stat-5107	**Course Title:** Statistical Methods for Reliability Data	**Credit Hours:** 3.00

Rationale: Statistical Methods for Reliability Datarefers to the fact that a scale should consistently reflect the construct it is measuring. There are certain times and situations where it can be useful.

Course Objectives:

- Understand the basic concepts of quality and reliability.
- Apply statistical knowledge and specialist techniques to estimate the likelihood or frequency of failures.
- Identify and correct the causes of failures that do occur despite the efforts to prevent them.
- Find out the failures and fit the appropriate failure time distribution.
- Apply methods for estimating the likely reliability of new designs, and for analyzing accelerated life test data.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Give the probabilistic foundation for calculating the reliability of a system.
2. Discuss and analyze discrete and continuous failure-time processes.
3. Introduce location-scale and log-location-scale distributions and estimate these models.
4. Plot different failure time data and fit appropriate life time distribution.
5. Apply different nonparametric and graphical techniques in accelerated life test (ALT) data.
6. Perform different modeling and estimation technique in software reliability data analysis.

Course Content:

Section – A	**Section – B**
Reliability and quality concepts: Basic concepts of quality and reliability, Examples and features of	**Accelerated test models and analyzing accelerated life test data:** Accelerating variables, life-stress

reliability data, Strategy for collection, modeling, and analysis of reliability data, Models for continuous failure-time processes, Models for discrete data from a continuous process. **Reliability estimation:**Maximum likelihood for location-scale and log-location-scale distributions, Confidence intervals for functions of parameters, Comparison of confidence interval procedures. **Probability plotting and choosing a failure-time distribution:**Probability plots, Empirical distribution function, Linearizing location scale-based distributions. Application of probability plotting, Weibull probability Plot, Other probability plots, Applications of probability plots, Bayesian intervals for parameters and reliability functions of Exponential, and Weibull distributions.	relationships and acceleration models, Guideline for the use of accelerating models. Non-parametric and graphicalmethods for presenting and analyzing accelerated life test (ALT) data, Likelihoodmethods for analyzing censored data from an ALT, Suggestions for drawingconclusions from ALT data, Potential pitfalls of accelerated life testing, series and parallel systems, Reliability of series and parallel systems,Competing risk, mixture, AFT, PH and parametric regression models and their applications in reliability, Model selection and validation, Graphical methods. Goodness-of-fit tests. **Software reliability:** Concept of Software reliability, Software reliability modeling and estimation, Software testing procedures, Management of software reliability.

Course No: Stat-5109	**Course Title:** Advanced Biostatistics	**Credit Hours:**3.00

Rationale: The goal of this course is to introduce and apply advanced statistical technique for public health related data as well as to solve clinical problems.

Course objectives:

- Design valid and efficient studies to address public health and clinical problems.
- Identify the broad range of data sources available for public health research
- Develop and refine a research question that can be adequately addressed using the available data
- Apply the knowledge and analytical skills gained, to inform health interventions from programme planning, implementation and evaluation.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Demonstrate ability to apply knowledge of the core disciplines and concepts of public health
2. Introduce students to the display and communication of statistical data
3. Understand various aspects of categorical, discrete and survival outcomes and their inherent challenges in data analysis
4. Apply a wide range of statistical models and distribution that deal with different types of life time data.
5. Gain deeper understanding of the statistical theory , specifically likelihood based inference that underlies statistical practice
6. Extend cox proportional hazard model beyond time independent covariates
7. Describe preferred methodological alternatives to commonly used statistical methods when assumptions are not met.
8. Interpret results of statistical analyses found in public health studies.
9. Apply goodness of fit test to evaluate the performance of the models
10. Estimate and compare efficiency of models.
11. Analyze correlated data.

Course Content:

Section – A	**Section – B**
Review of Inference procedures for parametric models: Inference procedures for parametric l distributions; grouped, interval censored, ortruncated data. **Inference procedure for log-location-scale distributions:** Inference for location-scale distributions; Weibull and extreme-value distributions; log-normal and log-logistic distributions; comparison of distributions; models with additional shape parameters. **Parametric regression models:** Introduction to log-location-scale regression models, proportional hazards regression models; graphical methods and model assessment; inference for log-location-scale models; extensions of log-location-scale models; hazard based models. **Semi parametric Multiplicative Hazards regression**	**Rank-Type Procedures for Log-Location-Scale models:** Rank tests for comparing distributions, estimation for semi-parametric accelerated failure time models. **Multiple Modes of Failure:** Basic characteristics of model specification, likelihood function formulation, nonparametric methods, parametric methods, semi parametric methods for multiplicative hazards model. **Analysis of Correlated Lifetime Data:** Introduction, regression models for correlated lifetime data, representation and estimation of bivariate survivor function.

Model: Introduction, estimation of parameters, inclusion of strata, time-dependent covariates, residuals and model checking, methods for Grouped or discrete lifetimes, related topics on the Cox model.	

Course No: Stat-5111	**Course Title:** Bayesian Statistics	**Credit Hours:**3.00

Rationale: This course is designed to Provide a principles-based understanding of Bayesian methods needed to train students, to evaluate papers and proposals, and to solve research problems

Course objectives:

- Concentrate the attention of learners to the central concepts in Bayesian statistics and its advantages over frequentist approach.
- Discuss the differences between Bayesian and traditional statistical methods
- Use probability models to quantify uncertainty in statistical conclusions, and acquire skills to perform practical Bayesian analysis

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Elucidate the similarities and differences between Bayesian and frequentist statistics
2. Derive prior, posterior and predictive distributions for standard Bayesian models
3. Apply Bayes' theorem to revise population parameters
4. Conduct decision analysis for cases without and with probability data
5. Use basic statistical distributions (e.g., binomial, Poisson, normal etc) to write joint and conditional posterior distributions for Bayesian models.
6. obtain point estimates and interval estimates from a posterior distribution
7. Tackle hierarchical analyses using sampling methods;
8. Compare and implement the most popular Bayesian simulation methods.
9. Explain how Markov chain Monte Carlo (MCMC) methods can be used to estimate the posterior distributions of parameters.
10. Write algorithms and computer code in R implementing MCMC methods to estimate parameters in simple models
11. Use analytic and simulation based methods for learning the parameters of a given model.
12. Develop and implement hierarchical models that explicitly partition uncertainties

Course Content:

Section – A	**Section – B**
Bayesian preliminary: Treating parameters as random variables, prior information about parameters, Bayes' theorem for combining information, building a predictive model, components of Bayes theorem - likelihood, prior and posterior; proper and improper priors; conjugate prior, Jeffreys' prior,method of finding conjugate prior; informative and non-informative priors; Bayes factor. **Bayesian inference and prediction:** single parameter models – Binomial, Poisson, normal with known variance, normal with known mean; multi-parameter models - concept of nuisance parameters, Averaging over nuisance parameters, normal model with a non-informative, conjugate, and semi-conjugate priors, multi-nomial model, multivariate normal model; inference based on Bayes factor.	**Bayesian computations:** summarizing posterior distributions - approximation methods, Monte Carlo method - direct sampling and acceptance-rejection sampling; importance sampling; Markov Chain Monte Carlo (MCMC) methods-Gibbs sampling, Metropolis-Hastings (MH) sampling, relationship between Gibbs and MH sampling; evaluating MCMC and model fit- assessing convergence, acceptance rates of the MH algorithm, autocorrelation; evaluating model fit; EMalgorithm - EM theory for regular exponential family, generalized EM algorithm; **Regression models:**Normal linear regression - model development, sampling from the posterior and predictive distribution using Gibbs and MH sampling algorithms; generalized linear models, model development, sampling from the posterior distribution and predictive distribution Gibbs and MH sampling algorithm.

Course No: Stat-5113	**Course Title:** Advanced Meta Analysis	**Credit Hours:**3.00

Rationale: This course is designed to provide the advanced concept of Mea-Analysis and to synthesize the available evidence for a given condition.

Course Objectives:

- Establish statistical significance with studies that have conflicting results
- Develop a more correct estimate of effect magnitude.
- Provide a more complex analysis of different meta-analytical situation.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Use meta-analysis in evidence based health care.
2. Apply fixed effect methods for combining studies and random effect model.
3. Identify and reduce publication bias.
4. Perform sensitivity analysis.
5. Display meta-analysis report by different graph.
6. Apply different Bayesian methods for different types of data in meta-analysis.
7. Explain the meta-analysis methods for different types of data.

Course Content:

Section – A	**Section – B**
Introduction: It's development and uses, evidence based health care, systematic reviews, why meta-analysis. **Fixed effect methods for combining studies:** inverse variance weighted method, specific methods for combining odds ratios: Mantel-Haenszel method, Peto's method, exact methods for interval estimation. **Random effect model:** Algebraic derivation,restricted maximum likelihood estimates, comparison of estimation methods, extensions to the random effects model. **Publication bias:** evidence and consequences of publication bias identifying publication bias, funnel plot, adjusting the publication bias. **Study quality**: methodological factors affecting the study quality, incorporating study quality in meta-analysis, Quality effects model. Sensitivity analysis, sensitivity of results to meta –analytic methods.	**Reporting the results of meta-analysis:** overview and structure of a report, graphical displays used for reporting, data collection and quality, PRISM. **Bayesian methods in meta-analysis:** Bayesian methods in health research, Bayesian meta-analysis of normally distributed data, Bayesian meta-analysis of binary data. Empirical Bayes methods in meta-analysis. Missing data, Bayesian method of missing data. **Meta-analysis of different types of data:** Meta-analysis of individual patient data (IPD). Vo5te counting methods, combining p-values. Meta-analysis of multiple and correlated outcome measures. Meta-analysis of epidemiological and other observational studies. Meta-analysis of survival data.

Course No: Stat-5115	**Course Title:** Time Series and Financial Econometrics	**Credit Hours:**3.00

Rationale: The goal of this course is to introduce advanced Time Series techniques and higher derivatives with applications in the economic systems.

Course objectives:

- Understand different Unit Root and Co-intregation Analysis.
- Appreciate the important features of Stylized facts of financial time series, volatility clustering and volatility models.
- Appreciate and apply key concepts Trading strategies involves options, Estimation of volatility and correlations, Panel data in a time series context.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Know Parametric and Non Parametric unit root tests.
2. Find out co-intregationproblem in system.
3. Estimate different components of time series analysis by using linear and nonlinear approaches.
4. Compute and interpret Time Series Models of Heteroscedasticity
5. Identify Trading strategies involves options, Estimate of volatility and correlations.
6. Forecast time series data with different techniques.
7. Carry out Panel data with estimation procedure and benefits as well as drawback.

Course Content:

Section – A	**Section – B**
Unit Root and Co-intregation Analysis- Parametric and Non Parametric unit root tests, specification of Null and Alternative hypothesis in different unit root tests like Moving average unit root tests, Phillips, Schmidt and Shin(Kpss) testetc, confirmatory analysis of unit root tests, different panel data unit root tests and their benefits and weaknesses, identification problem,estimation methods of co-intregation analysis, concept of multicointregation and polynomial intregation with examples, tests for co-intregation of single and multiple equation methods.	**Trading strategies involves options**- Mechanics of options markets, properties of stock options, concept of Binomial trees, Black-Scholes-Merton model-properties, distribution of the rate of return, idea and derivation of Black-Scholes-Merton differential equations. **Estimation of volatility and correlations-** Estimating volatility, The exponential weighted moving average model, GARCH(1,1) to forecast future volatility, Alternative to B-S model, Stochastic volatility models, IVF model.

Time Series Models of Heteroscedasticity-Stylized facts of financial time series, volatility clustering, detection of ARCH effects, ARCH model, GARCH model and mle of GARCH model, different ARCH models likeTARCH, EGARCH, IGARCH models, time series models of change in regime.	**Panel data**-Assumptions, dynamic completeness, robust asymptotic variance matrix, testing for serial correlation and heteroscedasticity after pooled OLS, feasible GLS estimation, basic linear unobserved and observed effects panel models.

Course No: Stat-5117	**Course Title:** Bioinformatics	**Credit Hours:**3.00

Rationale: This course is designed to provide fundamental concepts of biological science and introduce applications of statistics regarding the fields.

Course Objectives:

- Introduce the basic concept of bioinformatics
- Acquire the knowledge on the source of biological data and analysis procedure.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Develop the knowledge on the basic concept of the biology.
2. Identify the pattern of biological data.
3. Derive different analysis procedures of DNA sequence data.
4. Introduce the different online biological databases.

Course Content:

Section – A	**Section – B**
Introduction: Cell Structure and Function, Cell components. Different types of cell. Chromosome, Chromosome structure and organization. Cell division. DNA, RNA, Gene and Central dogma and bioinformatics. Cell chemistry and macromolecules. Amino acids, Biochemical pathways e.g. Glycolysis. **Analysis of DNA Sequence**: DNA sequencing. Shotgun sequencing, Long repeats, r-scane, Analysis of DNA patterns, Overlaps counted, Overlaps not counted and motifs, Sequence accuracy, Sequence formats, Conversions of one sequence format to another.	**Sequence Alignment**: Definition of sequence alignment, Significance of sequence alignment, Overview of methods of sequence alignment. Dot matrix sequence comparison, Dynamic programming algorithm for sequence alignment, Multiple Sequence alignments. Statistical methods for aiding alignment. **Biological Databases:** Overview of the use and maintenance of different databases in common use in biology. Databases: GenBank, CATH, DDBJ, EMB NCBI, Refseq, UniGene, UniProt, Swiss-Prot, PDB. BLAST and FASTA analysis.

Course No: Stat-5119	**Course Title:** Sample Survey Design	**Credit Hours:**3.00

Rationale: This course is designed to provide advanced and applied concept in different sampling techniques.

Course Objectives:

- Develop knowledge about complex design of sample survey.
- Identify sample size using different techniques.
- Contrast linear and nonlinear sampling in real life.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Formulate and modify complex sampling design.
2. Make an inference under fixed population and finite population using prediction theoretic approach.
3. Depict inference from complex sample.
4. Find out sample size in using various sampling techniques.
5. Comprehend the difference between sampling error and non-sampling error
6. Evaluate spatial sampling and its sampling design in compare to others.
7. Discover the optimal allocation for the number of call backs.
8. Generate adaptive sampling, adaptive cluster sampling and stratified adaptive sampling.

Course Content:

Section – A	**Section – B**
Review and Application of Multi-Stage Sampling, General Approach to obtain estimators. Brewer and Durbin's methods of selection of sample of size 2, Rao-Hartley and Cochran and Samford's methods of selection. Nonlinear estimation in complex surveys, Linearization (Taylor series) methods, Random group methods, re-	Review and application of multiphase sampling techniques, repeated sampling of some populations, longitudinal surveys. Sources and types of survey errors, Non-response, Types and Its Effects on accuracy of estimators, Techniques for adjustment of Non-Response, Modified Hansen-Hurwitz Estimator, Randomized

sampling and replication methods, Generalized variance functions, confidence intervals. Some problems of inference under fixed population Set up, Inference from finite population using prediction-theoretic approach, prediction under multiple regression models, inference from complex samples. Various techniques used in determining sample size under different sampling techniques, estimating population size using direct inverse sampling, estimating population density, design effects.Examples of national surveys of Bangladesh.	Response Method for Quantitative Data, Deming's Model for Effects of Call-backs, Politz-Simmons Technique, Randomized Response Method, Methods of Increasing Response Rates, Errors of Measurement, Mathematical Models, Imputations, Multiple Imputation for Non-Response, Maximum Likelihood Method for Non-Response. Spatial Sampling, Spatial Prediction or Kriging, Spatial Designs, Plot Shapes. Adapting Sampling, Adaptive Sampling Design, Adaptive Cluster Sampling, Stratified Adaptive Cluster Sampling.

Course No: Stat-5121	**Course Title:** Categorical Data Analysis	**Credit Hours:**3.00
Rationale: This course is designed to provide fundamental concepts of categorical data and categorical data models used in different fields of statistics.		
Course Objectives: ▪ Acquire knowledge about categorical data. ▪ Develop knowledge about different categorical data models.		
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to 1. Understand categorical data. 2. Differentiate between nominal and ordinal response data. 3. Gain the basic concept of different categorical data models. **4.** Apply these models in real life data set for different purposes.		
Course Content:		
Section – A	**Section – B**	
Introduction: Categorical response data, Sampling models, Inference for a proportion. **Two way Contingency Tables:** Probability Structure for contingency tables, Comparing proportions in two by two tables, The odds ratio, chi-squared test of independence, testing independence for ordinal data, exact inference for small samples. **Three way Contingency Tables:** Partial association, Cochran-Mentel-Haenszel methods, Exact inference about conditional associations	**Loglinear Models for Contingency Tables:** Loglinear models for two way tables, loglinear models for three way tables, inference for loglinear models, loglinear models for higher dimensions, the loglinear-logit connection. **Multicategory Logit Models:** Logit models for nominal responses, Cumulative logit models for ordinal responses, paired category logits for ordinal responses.	

Course No: Stat-5130	**Course Title:** Project	**Credit Hours:** 2.00
Rationale: This is a research basedprerequisite course for the course 'Stat-5230: Project' conducted by the supervisor(s)to provide research based knowledge and produce a substantial piece of work.		
Course Objectives: ▪ Develop student research curiosity and skills in critical and creative thinking, project management, and communication, which will enrich their subsequent academic and employment experiences.		
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to 1. Find out the own area of interest. 2. Identify own question and think critical way to solve problems in limited areas. 3. Develop and demonstrate analytical, judgmental, presentation and communication skills.		
Course Content:		
The respective supervisor will prescribe the topics of the project and help selected student/students to prepare the project.		

Course No: Stat-5140	**Course Title:** Statistical Computing-I	**Credit Hours:**1.00
Rationale: This course is designed to help the students to apply several statistical packages and software in real life problems.		

Course Objectives:

- Advanced application of several statistical packages and software.
- Perform database conversion in different format.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

- Perform statistical analysis with the statistical packages and software.
- Deal with large scale database and infer decision from the data and analyses.
- Construct different types of statistical model using software.

Course Content:

Solving practical problems by using several statistical packages and software, such as, SPSS, R, SAS, STATA, TORA, EVIEWS, MATLAB, etc., related to the following courses:
Generalized Linear Model, Applied Multivariate Analysis, Population Studies, Statistical Methods for Reliability Data, Advanced Biostatistics, Bayesian Statistics, Advanced Meta Analysis, Time Series and Econometric, Bioinformatics, Sample Survey Design and Categorical Data Analysis.

Year-1 Term-2
(For Thesis and Non-thesis Groups)

Course No: Stat-5200	**Course Title:** Thesis	**Credit Hours:** 6.00

Rationale: This is a research based course which is the continuous works of the course 'Stat-5100: Thesis'. The thesis provides an opportunity to gather research based knowledge and produce a substantial piece of work.

Course Objectives:

- Develop student's research curiosity and skills in critical and creative thinking, project management, and communication, which will be enriched their subsequent academic and employment experiences.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Find out the own area of interest and explore in depth.
2. Identify own question and think critical way to solve problems.
3. Experience the process of producing knowledge.
4. Develop and demonstrate analytical, judgmental, presentation and communication skills.
5. Use their communication, information-seeking and intellectual skills.

Course Content:

The respective supervisor will prescribe the topics of the thesis and help the selected student(s) to prepare the thesis paper.

Course No: Stat-5201	**Course Title:** Advanced Stochastic Process	**Credit Hours:** 3.00

Rationale: This course is designed to provide an advanced statistical knowledge of stochastic process and deliberate its related problems.

Course Objectives:

- Explicate the supremacy of stochastic processes and their variety of applications.
- Originate and explain problems which rivet setting up stochastic models.
- Apply appropriate stochastic model for research problems.
- Recommend regeneration and branching in real life.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

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

5. Categories as well as outline Markov chain, Lumpability and reversed Markov chain.
6. Determine appropriate stochastic continuous models for a problems and then task of frontier theorems in statistics.
7. Compare and justify fundamental properties of various stochastic models.
8. Evaluatedeath process and illness death process in coherent proofs of important theoretic results.
9. Apply the theory to model real phenomena and answer some questions in applied sciences.
10. Establish knowledge about different order of Markov chain, confidence interval of arrival rate and service utilization on queuing process.
11. Formulate and explain different process related problem on renewal process, branching process as well as social mobility.
12. Develop the models on biological sciences and business management on the perspective of social and industrial mobility.

Course Content:

Section – A	Section – B
Overview: Basic idea of stochastic process and Markov chain, Lumpability and reversed Markov chain. **Continuous Time Markov Chain**: Meaning, Birth and Death Process, Kolmogorov forward and backward equation of continuous time markov chain and their limiting probabilities. **Markov Chain Estimation and Hypothesis Testing related to Finite Markov Chain**: Maximum Likelihood estimates (MLE) of Transition probabilities, Testing of transition probability Matrix, Stationary of Transition Probability Matrix, order of Markov chain, First order Markov dependence, confidence interval of arrival rate, Service rate and service utilization of an M/M/1 Queue model.Stochastic Models of Population Growth.	**Renewal Theory and its Application**: Meaning of renewal process, distribution and limiting properties of renewal process, renewal reward process, Semi Markov process, renewal process in continuous time, Wald's equation, Stopping time and model equation, delayed and equilibrium renewal process, computation of renewal function, application to Patterns. **Branching Process**: Basic idea, Computing mean and variance, properties of Generating function of Branching process, total number of progeny and its distribution, continuous time Branching process, Generalization of classical Branching process.Social and Behavioural Processes.

Course No: Stat-5203	**Course Title:** Advanced Statistical Inference	**Credit Hours:** 3.00

Rationale: The goal of this course is to introduce highly developed notions of statistical inference and apply involved special skills in making decision.

Course objectives:

- Increase knowledge of complicated statistical inferential methods.
- Skilled of understanding different inferential techniques and their applications.
- Comprehend the utilization of re-sampling techniques in statistical fields.
- Acquaint with Bayesian Approach and minimal sufficient statistics.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Come across why and when we use different confidence intervals.
2. Execute difference confidence sets.
3. Apply Jackknifing, Kernel density estimation.
4. Compute Bayesian Approach, different statistical test with field oriented problems.
5. Familiar with SPRT, OC and ASN function, Armitage Method, Wald theory.
6. Recognize AIC in selecting models and testing hypothesizes.

Course Content:

Section – A	Section – B
Parametric estimations: Minimaxity and admissibility, Quasi-maximum and conditional likelihood methods of estimation, asymptotically efficient estimators, Confidence region, Fiducial &Tolerance limits. Review of statistical tests, Similar region test, MPSR, UMPSR test, Optimal test, locally UMPU test, tests under restricted alternatives, UMPSR test, SPRT for three hypothesis, Sobel and Wald test, Lagrange Multiplier test, Armitage method for composite hypothesis, Sequential t, Chi-square test, empirical Bayes testing of multiple hypothesis, Lindley's procedure for test of significance, Bayesian significance probability, Use of AIC in selecting models and testing hypothesizes. **Re-sampling Techniques:**Bayesian and Bootstrap intervals, UMA and UMAU confidence sets, construction of Bootstrap confidence sets and higher order accurate bootstrap confidence sets, bias-corrected bootstrap, Extension to 2- or more-sample problems in Jackknifing, Jackknifing in regression, and validity in Jackknifing.	**Non-Parametric estimation:**Definition of Kernel with Examples, Bias, MSE and IMSE, Choice of Kernel and smoothing parameter, Computation via fast fourier transform. Kernel estimates for non-negative and circular data, variable and adaptive Kernel estimators, Kernel estimation in non- parametric regression. **Bayesian Approach:** Conjugate family of prior densities, Loss function (symmetric & asymmetric Loss function) and Risk function, Bayes risk, Bayes estimation etc.

Course No: Stat-5205	**Course Title:** Statistical Signal Processing	**Credit Hours:**3.00

Rationale: The goal of this course is to introduce advanced techniques in statistical signal processing with applications in the domain of communication systems.

Course objectives:

- Transform random signals and random signal processing
- Develop Statistical signal processing, detection and estimation theory.
- Interpolate and decimate of discrete signals

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Analyze the implications at system level of the use of statistical signal processing techniques.
2. Process random signals to meet a particular requirement
3. Make a statistical classification of signals and random processes of telecommunications systems
4. Develop statistical filtering systems aimed at synchronization, equalization and detection in communications receivers
5. Apply advanced mathematical methods for the resolution of problems related to statistical signal processing
6. Develop and evaluate signal detection techniques with applications in positioning and radar systems.
7. Design and conduct experiments, analyze and interpret the data.
8. Use an appropriate software tool for data summary and data analysis.

Course Content:

Section – A	**Section – B**
Signals and their classification; real world analog signals: audio, video, biomedical (EEG, ECG, MRI, PET, CT, US), SAR, microarray, etc; digital representation of analog signals; role of transformation in signal processing. Signal estimation theory: Estimation of signal parameters using ML, EM algorithm, minimum variance unbiased estimators (Rao-Blackwell theorem, CRLB, BLUE), Bayesian estimators (MAP, MMSE, MAE), Linear Bayesian estimators (Wiener filter, Kalman filter).	Signal detection theory: Hypothesis testing; detection criteria (Bayes risk, Probability of error, Neyman-Pearson); LRT; detection with unknown signal parameters: UMP tests, Karlin-Rubin theorem, GLRT, Bayes factor. Application of signal estimation and detection theory to signal communication, signal recovery from various types of linear and nonlinear degradations, feature extraction, compression, pattern recognition, copyright protection, enhancement, etc

Course No: Stat-5207	**Course Title:** Machine Learning	**Credit Hours:**3.00

Rationale: Machine Learning course is design to gain the advance knowledge in different areas of general practice, research and development within the mathematical sciences.

Course Objectives:

- Be able to formulate machine learning problems corresponding to different applications.
- Understand a range of machine learning algorithms along with their strengths and weaknesses.
- Understand the basic theory underlying machine learning.
- Be able to apply machine learning algorithms to solve problems of moderate complexity.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Understand the idea about machine learning, machine learning tools and techniques.
2. Recognize when machine learning tools are applicable.
3. Plan and execute successful machine learning projects, including selecting an adequate process for your specific task and avoiding the main machine learning pitfalls.
4. Develop an appreciation for what is involved in learning from data.
5. Understand how to apply a variety of learning algorithms to data.
6. Understand how to perform evaluation of learning method and model selection.

Course Content:

Section – A	**Section – B**
Introduction: basic concept of machine learning, what and why? Supervised and unsupervised learning. **Clustering:** Introduction, clustering task, hierarchical clustering and nonhierarchical clustering methods, clustering based on statistical models. **Tree-Based Methods:** Basics of decision trees; regression trees, classification trees , trees versus linear, advantages and disadvantages of trees, bagging, random forests, boosting, bagging, random forests, boosting. **Kernel Methods:** Basic concept of kernel, different	**Artificial Neural Networks:** concept of neural networks, benefits of neural networks, Human Brain, models of neuron, McCulloch-Pitts Neuron, networks architectures, knowledge representation, different learning process (e.g. error-correction, memory based, Hebbian, Boltzmann learning), single layer and multilayer perceptions Bayesian learning for ANN models. **Deep Learning:** Introduction, different deep generative models, deep neural networks, application of deep networks.

kernel function (e.g. RBF, Mercer, linear, Matern, string, pyramid match kernel etc.), different kernel trick.	**Support Vector Machines:** Basic concept of support vector machines, linear and nonlinear support vector machines, multiclass support vector machines, support vector regression, support vector for classification.

Course No: Stat-5209	**Course Title:** Statistical Methods for Artificial Intelligence	**Credit Hours:**3.00

Rationale: This course is designed to explore the basis of Artificial intelligence which include reasoning, knowledge, planning, learning, natural language processing (communication), perception and the ability to move and manipulate objects.

Course Objectives:

- Develop the student's understanding of the issues involved in trying to define and simulate intelligence.
- Familiarize the student with specific, well known Artificial Intelligence methods, algorithms and results.
- Provide the student additional experience in the analysis and evaluation of complicated systems.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Explain both the achievements of AI and the theory underlying those achievements.
2. Handle different intelligent agent.
3. Perform different search strategies in AI.
4. Demonstrate working knowledge of reasoning in the presence of incomplete and/or uncertain information.
5. Ability to apply knowledge representation, reasoning, and machine learning techniques to real-world problems
6. Ability to carry out independent (or in a small group) research and communicate it effectively in a seminar setting
7. Apply different statistical method.

Course Content:

Section – A	**Section – B**
Introduction: what is Artificial Intelligence (AI), Application of AI, Philosophy of AI, AI research: problem of AI, approaches of to AI. **Intelligent Agents:** Agents and environments, Good behavior of the agents, Performance measures, the nature of environments, structure of agents: Simple reflex agents, Model based reflex agents, Goal based agents, Utility based agents. **Problem solving:** problem solving agents, formulating problem, uniformed search strategies: Breadth-first search, Depth-first search, Depth limited search, Iterative deepening depth-first search, Bidirectional search, Comparing uniformed search strategies. **Informed search strategies**: Heuristic function, greedy best-first search, Local search algorithms and optimistic problems: simulated annealing search and genetic algorithms.	**Knowledge representation:** Knowledge based agents, prepositional logic, Syntax and semantics, Equivalence, Validity and Satisfiability, Resolution. **First Order logic:** representation revisited, Syntax and semantics for first order logic, Using first order logic, inference in First order logic, prepositional versus first order logic, knowledge engineering in first order logic. **Uncertain knowledge and reasoning:** Handling uncertain knowledge (using knowledge of probability), inference using full joint distribution, independence, Bayes' rules and it use(simple case and combining evidence) **Probabilistic reasoning:** Bayesian network, method for constructing Bayesian network, conditional independence relations in Bayesian networks, Bayesian nets with continuous variables, exact inference in Bayesian network: variable elimination algorithm. **Statistical learning methods**: learning with complete data: Maximum –likelihood parameter learning (both discrete and continuous model), Decision Tree learning. Neural Networks: neural Networks, Units in neural networks, Network structures (single and Multilayer feed forward)

Course No: Stat-5211	**Course Title:** Advanced Data Mining	**Credit Hours:**3.00

Rationale: This course is designed to discover structure inside unstructured data, extract meaning from noisy data, discover patterns in apparently random data, and use all this information to better understand trends, patterns, correlations, and ultimately prediction.

Course Objectives:

- Understanding of the value of data mining in solving real-world problems.
- Gain the foundational concepts underlying data mining.
- Understanding of algorithms commonly used in data mining tools.
- Ability to apply data mining tools to real-world problems.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Display a comprehensive understanding of different data mining tasks and the algorithms most appropriate for addressing them.
2. Evaluate models/algorithms with respect to their accuracy.
3. Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques.
4. Critique the results of a data mining exercise.
5. Conceptualize a data mining solution to a practical problem.

Course Content:

Section – A	**Section – B**
Introduction To Data Mining: What and Why is Data Mining? Need for Human Direction of Data Mining, Fallacies of Data Mining, Tasks Can Data Mining, Some Case Studies, Preprocessing the Data, Data Cleaning, Handling Missing Data, Identifying Misclassifications, Graphical Methods for Identifying Outliers, Data Transformation, Min–Max Normalization, Z-Score Standardization, Numerical Methods for Identifying Outliers . **Exploratory Data Analysis:** Hypothesis Testing versus Exploratory Data Analysis, Getting to Know the Data Set, Dealing with Correlated Variables, Exploring Categorical Variables. **K-Nearest Neighbor Algorithm:** Supervised versus Unsupervised Methods, Methodology for Supervised Modeling, Bias–Variance Trade-Off, Classification Task, k-Nearest Neighbor Algorithm, k-Nearest Neighbor Algorithm for Estimation and Prediction, Choosing k.	**Decision Trees:** Classification and Regression Trees, C4.5 Algorithm, Decision Rules, Comparison of the C5.0 and CART Algorithms Applied to Real Data. **Ensemble methods:** Boosting, bagging & random forests. **Neural Networks and Kohonen Networks:** Input and Output Encoding, Simple Example of a Neural Network, Self-Organizing Maps, Kohonen Networks, Example of a Kohonen Network Study, Application of Clustering Using Kohonen Networks. **Model Evaluation Techniques:** Model Evaluation Techniques for the Description Task, Estimation and Prediction Tasks, and the Classification Task; Error Rate, False Positives, and False Negatives.

Course No: Stat-5213	**Course Title:** Advanced Bioinformatics	**Credit Hours:**3.00

Rationale: This course is designed to provide advanced concepts of bioinformatics and practices involved in different field of statistics.

Course Objectives:

- Derive the different analysis methods of genetics and genomics data ;
- Introduce the various analyzing software of genetics and genomics data;

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Acquire the knowledge on the statistical phylogenetic.
2. Apply different statistical methods for predicting protein function.
3. Apply the different clustering techniques for analyzing genetics data.
4. Acquire knowledge on GWAS.
5. Analyze the genetics and genomics data using different software.

Course Content:

Section – A	**Section – B**
Statistical Phylogenetic: Motivation and background on phylogenetic**, Distance** and clustering approach, Likelihood methods**,** Parsimony, RNA-based phylogenetic methods, Phylogenetic Tree Estimation. **Protein Classification, Structure and Prediction**: Protein Structure Prediction: Methods for predicting the secondary and tertiary structure of proteins. Techniques: neural networks, SVMs, genetic algorithms and stochastic global optimization.	**Statistical Analysis of Microarray Gene Expression Data:** Introduction to different types of microarray gene expression data. Preprocessing (Transformation, normalization, Image analysis and filtering). Identification of differential expressed (DE) genes in two or more groups using statistical test. Clustering and Classification of DE genes. Inferring genetic regulatory networks from microarray experiment with Bayesian networks. Modeling genetic regulatory networks using gene expression profile. Gene-set enrichment analysis. **Genome-wide SNPs and Haplotype Analysis**: Introduction to association. Analyzing genome-wide association (GWAS) study data using PLINK. Haplotype Estimation .Regional multilocus association

	models. Linkage disequilibrium and tagging. Practical guide to linkage disequilibrium analysis and tagging using Haploview.

Course No: Stat-5215	**Course Title:** Mathematical Demography	**Credit Hours:**3.00

Rationale: This course is designed to find the answers that will be serviceable to those working on population and related matters. This course also introduces how to develop a theory and model for population based problem in real situation.

Course Objectives:

- Concepts of different multiple life table and its application.
- Idea about projection and its application in population.
- Different estimation technique used in population
- Calculate and recognize basic demographic measures related to population structure and dynamics, fertility, mortality, and migration
- Describe and apply major demographic theories related to population structure and dynamics, fertility, mortality, and migration
- Fit different models in population based data.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Understand the basic idea about multiple decrement table
2. Construct multiple decrement table
3. Find different life function that are useful to construct life table
4. Know about population projection
5. Use different population projection technique for finding the future population of a country
6. Idea about indirect techniques involved in the Demographic Estimation
7. Estimate fertility and migration using different methods
8. Introduces the concept of a stable population and aims to provide an intuitive understanding of the properties of model stable populations
9. Find the mathematical relationship between growth rate and age structure within a stable population
10. Fit different model in stable population

Course Content:

Section – A	**Section – B**
Demographic Estimation-Concept and applicability of the indirect techniques involve in the estimation, Estimates of fertility, Estimation of migration, Dual record system, Chandra-Sekar and Deming Method, Coal's indices, Coal's nuptiality model. **Stable Population Models-**Concept of stationary, stable and quasi-stable population, annual growth rate and intrinsic growth rate, Lotka's integral equation, net maternity function, graduation of NMF- Normal, Wicksell and Hadwiger, effects of change of birth and death rate son stable population, study of some growth models - Exponential, Malthusian, Logistic and Quasi-stable models.	**Multiple Life Table Analysis-**Basic idea, ordinary life table, Properties and uses, methods of construction of double and multiple decrement tables and increment decrement life tables, joint life functions, multi-life functions, last survivor status, general multi-life status, life table analysis of birth intervals. **Population Projection-**The nature of population estimates and projection, methodology of estimates and projection, evaluation of the methods, projection of households and families and economically active population, cohort component method.

Course No: Stat-5217	**Course Title:** Advanced Environmental Statistics	**Credit Hours:**3.00

Rationale: Environmental Statistics is designed to enhance scientific inquiry and to strengthen scientific competence, recognizes the global changes and responses for attaining a more sustainable environment.

Course Objectives:

- Recognize major concepts in environmental sciences and demonstrate in-depth understanding of the environment.
- Develop analytical skills, critical thinking, and demonstrate problem-solving skills using scientific techniques.
- Demonstrate the knowledge and training for entering graduate or professional schools, or the job market.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Understand the natural environment and its relationships with human activities.
2. Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.
3. Design and evaluate strategies, technologies, and methods for sustainable management of environmental

systems and for the remediation or restoration of degraded environments.
4. Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.
5. Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
6. Describe common earth materials and their relationship to natural hazards.
7. Explain how Earth and Solar System processes create hazards to life and property.
8. Describe and explain the most common methods used to mitigate and prepare for each type of hazardous natural process andexplain the causes and effects of global climate change.

Course Content:

Section – A	**Section – B**
Introduction: **Environmental Variables** - Discrete and continuous; Data collection - primary and secondary; Presentation of data - spatial and non-spatial data; **Hazard in the environment:** Concept of risk, vulnerability, hazard, and disaster; Types of Natural Hazards and their Global and National perspectives Role of Global climatic changes and Global warming. Causes and consequences of Global Warming,Sea level rise in climate. **Study of Agro-meteorological features:** Fundamentals Concept of meteorology and Climatology.Desertification,**Drought and Flood management and Modeling Analysis**:**Flood hazard and its management**: Definition, Causes, nature, frequency of flooding and its impacts.**Desertification and Drought** – Causes of desertification; Evaluation of desertification hazard–potential and zoning: Drought - causes, types, distribution and management.	**Food security and Environmental impact on health and agriculture**: Pollution and Soil degradation, Deforestation, Land use pattern and regional pattern of productivity. **Study of environmental data analysis:** (i) Applications of probability distributions and Markov chain model.Drought Identification and Characterization at Local Level, National Level and Global level: (a) Drought indices by Standardized Precipitation Index (SPI), (b) Drought Prediction Using Markov chains modeling, (c) Drought Prediction Using Log-linear models, (d) Drought indicators: A Stochastic approach to evaluation. (ii) Applications of Non-linear and non-stochastic Time series analysis, Wavelets analysis, Spectral analysis. (iii) Applications of geo-statistical modeling analysis, spatio-temporal modeling, Extreme value modeling. (iv) Study of validity and uncertainty in environmental modeling. **Geographical Information System (GIS):** Basic principles, Raster and vector data, Map Projection, Overlay analysis, Data structure and Digital cartography. **Global Positioning System (GPS):** Basic principles, Applications to environmental studies

Course No: Stat-5219	**Course Title:** Health Studies	**Credit Hours:**3.00

Rationale: This course is designed to provide **a clear** statistical knowledge **as to the wellbeing of a population** on health and health related problems.

Course Objectives:
- Develop knowledge about health problems.
- Demonstrate health, health problems and concern about health.
- Apply statistical techniques in health statistical data.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to
1. Categorize health problems and determine the factors for diseases.
2. Discriminate health study in different research problems.
3. Measure the source of health diseases and concern about these.
4. Verify ethical issues related to health study.
5. Formulate design on infant and child nutrition.
6. Operate health policy and family planning.
7. Modify couple year protection and effectiveness on contraceptive use.
8. Criticize population, truncation estimator of age at first marriage, influence of age structure on fertility.

Course Content:

Section – A	**Section – B**
Introduction: Some examples of health study,	**Health Policy of Bangladesh**: Reasons of health

selection of health problem for research, Framing different type of study design, prospective study, retrospective study, longitudinal study, experimental study, observational study, interventional study, single blind study, double blind study, selection of study population and case for the study, causal variables, confounder variables, Ethical issue related to health study. **Measuring death and diseases**: Sources of health statistics, Meaning and concept, biological variables, health indicators classification, morbidity concepts and measures, illness, diseases and their classifications, multiple causation of diseases, the conquest and resurgence of infectious diseases, chronic disease, measuring diseases frequency and error measurement, mortality, nutrition in Bangladesh, special emphasis on infant and child nutrition.	policy, health infrastructure information, selected health and family planning indicators, national health policy (NHP), objectives of national health policy, principles of national health policy. **Couple Year Protection**: Definition, Sterilization (Conversion Factor, Achievement Index, Prevalence Index), Tubectomy, Intrauterine Device (IUD), Vasectomy. **Effectiveness of Contraceptive Use**: Fecundability and Fecundity, Life table Analysis of Contraceptive Failure, Construction of Single and Multiple Life Table. **Decomposition of Changes in TFR between two time periods:** Bongaart's model, target setting by Bongaarts model, Relationship between target fertility and contraceptive use, Bongaarts revised model. **Truncation estimator of Age at first marriage**: Truncation or censoring, estimate mean age and marriage of truncated distribution. **Influence of Age Structure on Fertility**: Estimation of fertility when it is affected by age structure.

Course No: Stat-5221	**Course Title:** Optimum Experimental Designs	**Credit Hours:**3.00

Rationale: This course is designed to tackle the problems that go beyond the frame of simple experimental design and deal with advanced design.

Course Objectives:

- Maximize the information on what is of interest with the minimum use of resources.
- Set optimality criteria in real life situation.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Develop algorithm and generate function for optimization
2. Solve the problems related to D-optimum design
3. Experiment with qualitative and quantitative factors
4. Apply Bayesian approach to optimum and checking the adequacy of the model under different situations.

Course Content:

Section – A	**Section – B**
Introduction: Review of basic of experimental design Optimum design theory : continuous and exact designs, the general equivalence theorem, algorithms for continuous designs and general equivalence theorem, function optimization and continuous design Criteria of optimality: A-, D-, and E-optimality; D_A-optimality, D_S-optimality, c-optimality, linear optimality; compound design criteria.	D-optimum designs: properties of D-optimum designs, sequential construction of optimum designs, polynomial regression in variable, second-order model with several variables. Algorithms for constructing of exact D-optimum designs: the exact design problem, basic formulae for exchange algorithm, sequential algorithms, non-sequential algorithms. Experiments with both qualitative and quantitative factors, blocking response surface designs, mixture experiments, non-linear models, Bayesian optimum designs, model checking.

Course No: Stat-5230	**Course Title:** Project	**Credit Hours:** 2.00

Rationale: This is a research based course which is the continuous works of the course 'Stat-5130: Project'. The project provides an opportunity to gather research based knowledge and produce a substantial piece of work.

Course Objectives:

- Develop student research curiosity and skills in critical and creative thinking, project management, and communication, which will enrich their subsequent academic and employment experiences.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to

1. Find out the own area of interest.
2. Identify own question and think critical way to solve problems in limited areas.
3. Develop and demonstrate analytical, judgmental, presentation and communication skills.

Course Content:
The respective supervisor will prescribe the topics of the project and help selected student/students to prepare the project.

Course No: Stat-5240	**Course Title:** Statistical Computing-II	**Credit Hours:**1.00
Rationale: This course is designed to help the students to apply several statistical packages and software in real life problem.		
Course Objectives: ▪ Advanced application of several statistical packages and software. ▪ Perform database conversion in different format.		
Intended Learning Outcomes (ILOs): At the end of the course the students will be able to ▪ Perform statistical analysis with the statistical packages and software. ▪ Deal with large scale database and infer decision from the data and analyses. ▪ Construct different types of statistical model using software.		
Course Content:		
Solving practical problems by using several statistical packages and software such as SPSS, R, SAS, STATA, TORA, EVIEWS, MATLAB, etc.,related to the following courses: Advanced Stochastic Process, Advanced Statistical Inference, Statistical Signal Processing, Machine Learning, Statistical Methods for Artificial Intelligence, Advanced Data Mining, Advanced Bioinformatics, Mathematical Demography, Advanced Environmental Statistics, Health Studies and Optimum Experimental Designs.		