Department of Mathematical & Physical Sciences

Course Descriptions of the Core Courses for B.Sc. in Data Science & Analytics

MAT101– Differential & Integral Calculus

Course Rationale:

Calculus is a transition course to upper-division mathematics and computer science courses. Important objectives of the calculus sequence are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content:

Differential Calculus: Limit, Continuity and differentiability. Successive differentiation of various types of functions, Leibnitz's theorem, Rolle's theorem, Mean value theorems, Taylor's and Maclaurin's theorems in finite and infinite forms, Lagrange's form of remainders, Cauchy's form of remainders, Expansion of functions, Evaluation of indeterminate forms by L'Hospital rule, Partial differentiation, Euler's theorem, Tangent and normal, Concavity of functions, Determination of maximum and minimum values of functions and points of inflection with Applications, Curvature, Asymptotes.

Integral Calculus: Integration by the method of substitution, Standard integrals, Integration by successive reduction, Definite integrals, its properties and use in summing series, Walli's formulae, Improper integrals, Beta function and Gamma function, Area under a plane curve and area of a region enclosed by two curves in Cartesian and polar co-ordinates, Volumes of solids of revolution, Volume of hollow solids of revolution by shell method, Area of surface of revolution, Jacobians, Multiple integrals with applications

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3				√					
CLO 4							√		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain /Level	Assessment Tool
CLO 1	Understand the basic concepts and principles of differential and integral calculus of real functions and series.	Understand	Term and Final Examination
CLO 2	understand the geometric meaning of differential and integral calculus.	Understand	Term and Final Examination
CLO 3	apply the concept and principles of differential and integral calculus to solve real-life problems.	Apply	Term and Final Examination
CLO 4	analyze the properties of functions based on graph.	Analyze	Assignment

MAT102– Differential Equations & Special Functions

Course Rationale:
Differential equations and Special functions are essential tool for describing the nature of the physical universe. This course aims to develop necessary skills required by the students for solution of differential equations and Special functions.

Course Content:
Ordinary Differential Equations: Degree and order of ordinary differential equations. Formation of differential equations. Solutions of first order differential equations; Separable & homogeneous equations, Exact equation. Integrating factor. Equations made exact by integrating factors. First order linear equation. Bernoulli's equation. Higher order linear homogeneous equation with constant coefficients. Initial and Boundary value problems. Linear non-homogeneous equation with constant coefficients: Method of undetermined coefficients, Method of variation of parameters, Operator method; Series solution; Frobenius method.

Partial Differential Equations: Formation of PDEs & First order linear PDEs, Solution of PDEs of first order; Lagrange's Method, Second Order homogeneous & non-homogeneous PDEs with constant coefficients, Wave equations, Particular solutions with boundary and initial conditions.

Special Functions: Legendre differential equation and Legendre polynomials, Recurrence relations for Legendre polynomials, Spherical harmonics, Bessel differential equation, Bessel functions, Recurrence relations for Bessel functions, Modified Bessel functions, Hermite differential equation, Hermite polynomials, Hyper-geometric function.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3		√							
CLO 4			√						

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	understand of basic concepts of the differential equations.	Understand	Term and Final Examination
CLO 2	solve differential equations as well as the systems of such equations.	Evaluation	Term and Final Examination
CLO 3	apply the knowledge of the differential equations to analyze dynamics of the processes.	Apply	Term and Final Examination
CLO 4	apply computational tools to analyze the solutions.	Apply	Assignment/Project

MAT291–Linear Algebra

Course Rationale:
This course introduces the student to matrices, vector spaces and vector geometry. The course will emphasize the ways in which geometric and algebraic concepts, reinforce each other, and the ways in which these concepts can be generalized and applied to practical situations.

Course Content:
Introduction to matrix; different types of matrices, Methods for finding inverse of matrix, Concept of generalized inverse, canonical forms of matrices, rank of a matrix; Cofactor expansion, Formation of adjoint matrix; System of Linear Equations: Gaussian elimination and Gauss-Jordan elimination method, Application of Matrices for solving system of linear equationsfor full rank and non-full rank problems, LU- decompositions; General vector space: Subspace, Linear

combination, Linear independence and dependence, Basis and dimension, Row space, column space and null space; Inner Product spaces: Angle and orthogonality in inner product spaces, Orthonormal bases, Gram-Schmidt Process, QR-Decomposition, Best approximation, Least squares, Change of bases; Linear transformations**:** kernel and image of a linear transformation, rank and nullity, Matrix representation of linear transformations, Isomorphism; Diagonalization of matrices: Eigen values and Eigen vectors, the minimum polynomial of a matrix and the Cayley-Hamilton theorem.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3		√							
CLO 4				√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	understanding of the concepts of vector space and subspace, linear independence, span, and basis.	Understand	Term and Final Examination
CLO 2	apply principles of matrix algebra to linear transformations.	Apply	Term and Final Examination
CLO 3	solve systems of linear equations using multiple methods.	Evaluate	Term and Final Examination
CLO 4	applications of linear systems in sciences and engineering.	Apply	Assignment/Project

MAT295– Discrete Mathematics

Course Rationale:

This course introduces discrete objects such as integers, rational numbers, propositions, sets, relations, functions etc. The aims of this course are to learn concepts associated with mentioned topics, their properties, and relationships among them and others.

Course Content:

Logic: Propositional Logic, Applications of Propositional Logic, Proof Methods; Sequences and Summations, Cardinality of Sets, Algorithms; Induction and Recursion, Recursive Algorithms, Counting principles, The Pigeonhole Principle; Recurrence Relations, Inclusion–Exclusion with Applications; Relation and their properties, Closure of Relations, Equivalence Relations; Graphs and Graph Models, Euler and Hamilton Paths, Shortest Path Algorithm, Planar Graph, Graph Coloring; Introduction to Trees, Spanning Tree Problems; Boolean Algebra: Functions and Logic Gates, Minimization of Circuits.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2				√					
CLO 3							√		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	relate the knowledge and skills obtained to investigate	Understand	Term and Final

	and solve a variety of discrete mathematical problems and know how to use them in appropriate technology.		Examination
CLO 2	identify and apply fundamental concepts of proof techniques, binary relations, graphs and trees.	Apply	Term and Final Examination
CLO 3	use the mathematical concepts learned to apply in various areas of computer science and engineering.	Apply	Term and Final Examination

MAT397– Numerical Methods and Optimization

Course Rationale:

The numericaland optimization methods are necessary for estimating the statistical models. This course will give a solid foundation to make students acquire a systematic understanding of the numerical and optimization methods.

Course Content:

Numerical solution of algebraic equations- Bisection Method, Newton-Raphson Method, etc. Errors in numerical solutions, Interpolation and Polynomial Approximation: Concept of Interpolation and Extrapolation, Interpolation and Lagrange Polynomial, Finite Differences.

Basics of optimization theory; linear programming (simplex method, duality theory); unconstrained methods (optimality conditions, descent algorithms and convergence theorems); constrained minimization (Lagrange multipliers, Karush-Kuhn-Tucker conditions, active set, penalty and interior point methods). Applications in engineering, operations, finance, statistics, etc.Use of R/Python optimization toolbox to obtain practical experience with the materials.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3	√								
CLO 4				√					
				√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Understand the linear programming problems the simplex method for linear programming	Understand	Assignment, Term and Final Examination
CLO2	Learn nonlinear programming with constraints and no constraints	Understand	Term and Final Examination
CLO3	Understand multi-objective optimization and be able to generate Pareto	Understand	Assignment, Term and Final Examination
CLO4	Be able to model complex systems using surrogate modeling and design space reduction techniques	Apply	Term and Final Examination
CLO5	Be able to apply numerical packages to solve optimization problems	Apply	Term and Final Examination

STA191– Probability & Statistics

Course Rationale:

Probability and statistics allows data scientists to assess the certainty of outcomes of a particular study or experiment. A solid understanding of probability and statistics is crucial for anyone who wants to work with data in data science.Thus, this course will provide the beginners to understand the fundamental probability and statistics concept with simple examples.

Course Content:

Introduction to statistics, Summarizing and presenting data, frequency distribution, formation of discrete and continuous frequency distribution, Measures of central tendency and dispersion; Skewness and Kurtosis; Detection of outliers for univariate data; Correlation for different types of data and simple linear regression; Definition and scope of probability, Set theory, elements of set theory; Probability for simple and compound events; Conditional probability, Additive and Multiplicative rules; Bayes' theorem.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3			√						
CLO 4	√								
CLO5			√						

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Understand statistical terms and notations, construct frequency tables, plots.	Understand	Term and Final Examination
CLO2	analyze data and interpret the statistical outputs	Analyze	Assignment, Term and Final Examination
CLO3	Compute and summarize numerical data with basic statistics.	Apply	Assignment, Term and Final Examination
CLO4	Understand the terms of probability and the probability of simple and compound events	Understand	Term and Final Examination
CLO5	Solving basic probability problems	Apply	Assignment, and Final

STA293– Probability Distributions

Course Rationale:

This course extends the basic probability theory to accommodate different probability distributions.A solid understanding of probability distribution is crucial for data scientist. Thus, this course will provide to understand the probability distribution and their applications in data science.

Course content:

Random variables; basic concept of probability distribution; Commonly used distribution functions; Mathematical expectations; Discrete probability distributions and their characteristics; Continuous probability distributions and their characteristics. Transformations of random variables and their distributions; Sampling distribution concept; Sampling distribution of some common statistics; Central limit theorem; Order statistics.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1			√						
CLO2	√								
CLO3			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Apply appropriate probability distribution to a	Apply	Assignments, Term and

	particular problem		final examination
CLO2	Find distribution of a transformed random variable	Understand	Assignments, Term and final examination
CLO3	Find distributions of some common statistics	Remember	Assignments, final examination

STA395– Statistical Inference

Course Rationale:

Data scientists often simulate the samples to understand how the population behaves and for that they make assumptions about the underlying probability distributions of the variable. This course will help the data scientist to make propositions about the entire population and that is why this course is very important.

Course content:

Review of the concepts of parameters and statistics; sampling distribution; standard normal, t, F, and chi-square statistics; Point Estimation and properties of good Estimator, Maximum likelihood estimator, Methods of moments estimator, Least squares estimator; Confidence interval for the mean, variance, and proportions, parametric test of hypothesis for large and small samples; Nonparametric tests. The Maximum likelihood estimation, multidimensionality in parameters, Newton–Rapson, Markov chain Monte Carlo (MCMC), Expectation Maximization (EM)algorithm.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO 6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3				√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understand the basic ideas and methods about fundamental principles for statistical inference.	Understand	Term and Final Examination
CLO 2	knowledge about construction of point and interval estimators, and hypothesis testing (parametric and non-parametric)	Understand	Term and Final Examination
CLO 3	Perform point and interval estimation, hypothesis testing (parametric and non-parametric) under a large variety of situation.	Apply	Term and Final Examination

CS191–Programming with C

Course Rationale:

C Programming is must to learn for everyone who are interested in programming and want tostart their career in Data Science. It is the basic foundation of any programming languages. All the programming languages like java, or any object oriented programming language are all inherited from C.

Course Content:

Programming with C; Fundamentals in C; Operators and Expressions; Data types; Input-Output Library Functions; Control statements; Function, Storage class;Pointer;Pointer and Function;Array; Pointer and array; Array and function; Dynamic memory allocation; String; String and function; Command line arguments; Preprocessor; Structure; Structure and function; File Handling.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3				√					
CLO 4			√						
CLO 5						√			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Understand the advantages of a high level language like C, the programming process, and the compilation process.	Understand	Term and Final Examination
CLO2	Describe and use software tools in the programming process.	Analyze	Assignment, Term and Final Examination
CLO3	Apply good programming principles to the design and implementation of C programs.	Analyze	Term and Final Examination
CLO4	Design, implement, debug and test programs using the fundamental elements of C.	Apply	Assignment, Term and Final Examination
CLO5	Demonstrate an understanding of primitive data types, values, operators and expressions in C.	Apply	Term and Final Examination

CS295– Programming with Python

Course Rationale:

This is the computing course which will help the students have the basic knowledge of data and statistics needed to go for computation. This programming software Python provides the user a wide scope of data manipulation and analysis of interest.

Course Content:

Downloading and Installing Python- Running Python; Basic Syntax; Interactive mode Programming –Script mode Programming –A simple Python Example-Python Libraries; Data, expressions, statements; Control flow, functions conditionals: Lists, tuples lists; Dictionaries, files dictionaries; Modules and Packages: Built-in modules, User-defined modules, Object oriented programming; overview of NumPy and Pandas package.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1		√							
CLO 2		√							
CLO 3						√			
CLO 4						√			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Designed to engage in the basic knowledge of Python	Understand	Term and Final Examination
CLO2	Intended to learn the concepts of Statements, Tuples, conditionals, iteration, functions, and strings in Python	Analyze	Assignment, Term and Final Examination

| CLO3 | Engage in gaining the concepts of Lists and Tuples. | Analyze | Term and Final Examination |
| CLO4 | To apply the knowledge regarding dictionaries and files | Apply | Assignment, Term and Final |

CS397– Data Structure & Algorithm

Course Rationale:

Data structures and algorithm design methods impacts the performance of programs. Thus, this course will help to choose the appropriate data structure and algorithm design method for a specified application.

Course Content:

An overview of data structure concepts, arrays, stacks, queues, trees, and graphs. Abstract data types and data structures, Classes, and data objects; The complexity of Algorithms: worst case, average case, and amortized complexity; Algorithm analysis; Algorithm design paradigms. Lists: stacks, queues, implementation, garbage collection. Dictionaries: hash tables, binary search trees, AVL trees, red-black trees, splay trees, skip-lists, B-trees; Priority queues; Graphs: Shortest path algorithms, minimal spanning tree algorithms, depth-first, and breadth-first search; Sorting: Advanced sorting methods and their analysis, lower bound on complexity, and order statistics; Algorithm analysis and efficient code design.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3		√							

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Good understanding of the basic data structure.	Understand	Term and Final Examination
CLO 2	The knowledge to implement abstract data types.	Understand	Assignment, Term, and Final Examination
CLO 3	The ability to use an appropriate data structure to solve a problem.	Analyze	Term and Final Examination

CS399–Artificial Intelligence

Course rational:

Artificial intelligence (AI) is a research field that aims to make a computer that can learn, plan, and solve problems autonomously like intelligent human. The main purpose of this course is to provide the most fundamental knowledge to the students so that they can understand what the AI is and be able to understand the possible applications of AI in real systems.

Course content:

An introduction to the basic principles, techniques, and applications of Artificial Intelligence; Coverage includes knowledge representation, logic, inference, problem solving, search algorithms, game theory, perception, learning, planning, and agent design; Programming in AI language tools; Potential areas of further exploration include expert systems, neural networks, fuzzy logic, robotics, natural language processing, and computer vision.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2			√						
CLO3					√				
CLO4			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Demonstrate fundamental understanding of the AI and its foundations.	Understand	Term and final examination
CLO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.	Apply	Assignments, Term and final examination
CLO3	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.	Apply	Assignments, Term and final examination
CLO4	Demonstrate proficiency in applying scientific method to models of machine learning.	Analyze	Assignments, Term and final examination

DSA101– Introduction to Data Science

Course Rationale:

This course will provide the beginners to understand the fundamental concept of data with various examples. From this course, the beginners will understand their role as a data scientist in various filed like economics, psychology, social sciences, business, sports, medicine, biology etc.

Course Content:

Introduction to Data, Stages in a Data Science project, Applications of Data Science in various fields, types of data, text, image, audio, and video data; sources of data; tools and techniques for data managing using computer,big data, Data security Issues and ethics of data;visualizing and making sense of data;Missing data, data cleaning, Data integration and transformation, Data reduction, Data discretization; basic statistics; Devolving questionnaire, Sampling methods for data collection; Demonstrate the ability to clean and prepare data for analysis and assemble data from a variety of sources; Introduction toR/ SPSS/ Excel/ Minitab software to work with basic data computation.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3		√							

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understanding of the basic data structure.	Understand	Term and Final Examination
CLO 2	Choose appropriate sampling methods for data collections and understanding data ethics.	Understand	Assignment, Term, and Final Examination
CLO 3	Ability to use an appropriate data to solve a problem.	Understand	Term and Final Examination

DSA201– Data Processing & Storage

Course Rationale:

The objective of the course is to present an introduction to database management systems, emphasizing how to organize, maintain and retrieve - efficiently and effectively - information from a DBMS.

Course Content:

Database System- concepts and architecture; The Relational Model;ConceptualModelingData Definition Languages and SQL; Relational Algebra and SQL; Database Design and Normalization; Triggers and Active Databases; Physical Data Organization and Indexing;Dynamic Multi-level indexing using B Trees and B+ Trees, Query Processing; Transaction Processing; Design Coding and Testing

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2				√					
CLO 3				√					
CLO 4			√						

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

	CLO Description	Domain/Level	Assessment Tool
CLO 1	Describe the fundamental elements of relational database management systems.	Understand	Term and Final Examination
CLO 2	Explain the basic concepts of the relational data model	Understand	Assignment, Term Examination
CLO 3	Design models to represent simple database application scenarios	Analyze	Term and Final Examination
CLO 4	Improve the database design.	Analyze	Term and Final Examination

DSA303– Regression Analysis

Course Rationale:

Real-life events are related to each other make up a system; one or more events influence one or more other events. To understand such a system, and to make prediction or forecasting for those systems linear model is essential. i.e., regression modeling are a great tool.

Course content:

Simple and Multiple linear regression models, estimation, assumptions, residual analysis; Reduced and full models, F test for general linear hypothesis. Dummy variables regression model, Collinearity and influence measures such as Cook's D, CovRatioetc; detection of outliers by residual analysis; Model Selection such as forward selection, backward elimination, and stepwise algorithm, Model selection criterions such as AIC, BIC, DIC, HQIC, Nonlinear regression, Robust regression.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√				√				
CLO2					√				
CLO3			√	√					
CLO4					√	√			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Build simple, multiple, polynomial and non-linear regression models	Create	Assignments, Term and final examinations
CLO2	Evaluate an estimated regression model's performance through rigorous statistical tests and measures	Evaluate	Assignments, Term and final examinations
CLO3	Diagnose model assumptions through visualization of residuals and different statistical measures	Analyze	Assignments, Term and final examinations
CLO4	Select best models among all possible regression models through step-by-step systematic methods.	Analyze	Assignments, Term and final examinations

DSA305–Multivariate Analysis

Course Rationale:

In many observational or designed studies, observations are collected simultaneously on more than one variable on each experimental unit. Multivariate analysis is the collection of methods that can be used to analyze these multiple measurements. Thus, this course introduces the student to various multivariate data analysis tools and dimension reduction techniques for multivariate data.

Course content:

Multivariate data; data display and pictorial representations, multivariate distance; Random vectors and random sampling; The multivariate normal distribution; application of Mahalanobisdistance; The plausibility of mean vector as a value for a normal population mean, Hotelling T^2 and likelihood ratio tests, multivariate confidence intervals; Comparisons of several multivariate means; Principal components analysis; factor analysis; Canonical correlation analysis;Cluster analysis; Discrimination and Classification.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO 1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3					√				
CLO 4						√			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understand the principles and characteristics of the multivariate data analysis, including strengths and weaknesses.	Understand	Term and Final Examination
CLO 2	Select appropriate techniques of multivariate analysis for a multivariate dataset.	Understand	Term and Final Examination
CLO 3	Apply the multivariate methods in the framework of the multivariate analysis.	Apply	Term and Final Examination
CLO 4	use the statistical software to analyze data and to make proper interpretations of the results.	Analyze	Term and Final Examination

DSA307–Generalized Linear Model

Course Rationale:

The course will help the students to build statistical models where the response data may follow any particular probability distribution. The emphasis will be given in finding the link which will help the students derive the models. This course will also guide the students on the procedure of comparing the models and finding out the best fitted one.

Course Content:

Introduction to the Concepts of Modeling; Model Fitting, Exponential Family and Generalized Linear Models (Bernoulli, Binomial, Poisson, Exponential, Gamma, Normal, etc.); Properties of distributions in the exponential family, Random, Systematic and Link Functions, Poisson Regression; Maximum Likelihood Identity Link, Logit Link, Log Link, Parameter Estimation; Score Function and Information Matrix, Estimation, Residuals analysis for GLM, Quasi Likelihood Estimating Equations, Generalized Estimating Equations for Repeated Measures Data, Comparison between Likelihood and Quasi Likelihood Methods, Mixed Effect Models.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2					√				
CLO 3				√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain /Level	Assessment Tool
CLO1	Understanding the probability distribution of the population from where the samples are derived	understand	Term and Final Examination
CLO2	Find the link to derive statistical model	Apply	Assignment, Term and Final Examination
CLO3	Compare the models to find the best one and get the inference from the model	Analyze	Assignment, Term and Final Examination

DSA401–Data Mining

Course Rationale:

Data Mining studies algorithms and computational paradigms that allow computers to find patterns and regularities in databases. It is currently regarded as the key element of a more general process called Knowledge Discovery which process includes data selection, cleaning, coding, using different statistical and machine learning techniques, and visualization of the generated structures. The course will cover all these issues and will illustrate the whole process by examples.

Course Content:

Introduction to data mining; Measurements and distances; Systematic overview of data mining algorithms – decision trees and MLP, association rules and text retrieval; Model and Patterns – prediction models, probability models and graphical models, structured data and Markov models, pattern structures; Content-based Information Retrieval – precision and recall, text retrieval with term frequency and inverse document frequency, text retrieval with latent semantic indexing and probabilistic retrieval, content-based image retrieval.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2			√						
CLO 3			√						
CLO 4					√				

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Conceptualize basic applications, concepts, and techniques of data mining	Understand	Term and Final Examination
CLO 2	Identify appropriate data mining algorithms to solve real world problems	Analyze	Assignment, Term, and Final Examination
CLO 3	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining	Analyze	Term and Final Examination
CLO 4	Apply knowledge of data mining in developing research ideas	Apply	Term and Final Examination

DSA403– Machine Learning

Course Rationale:

Machine learning is the field of AI that uses data to learn and make predictions or decisions without being explicitly programmed. This course covers basic machine learning techniques and applications.

Course content:

Definition, scope and challenges of machine learning; Basic concepts and terminologies; Supervised learning methods;Unsupervised learning methods; Evaluation and validation techniques for supervised and unsupervised methods such as ROC curve, MSE;Hold-Out Method, K-Fold Cross Validation; Leave one out cross-validation (LOOCV); Reinforcement learning methods and their evaluation and validation techniques; Bias-variance tradeoff, regularization, model selection; applications of machine learning.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1				√					
CLO2				√					
CLO3				√					
CLO4					√				
CLO5			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Use supervised learning algorithms in ML	Apply	Assignments, Term and final examination
CLO2	Use unsupervised learning algorithms in ML	Apply	Assignments, Term and final examination
CLO3	Use reinforcement learning algorithms in ML	Apply	Assignments, Term and final examination

| CLO4 | Evaluate the performances of above models | Evaluate | Assignments, Term and final examination |
| CLO5 | Validate the outcomes from above models | Evaluate | Assignments, Term and final examination |

DSA405– Big Data & Cloud Computing

Course Rationale:

The aim of this course is to provide students with the foundation knowledge and understanding of Big Data and distributed computing systems and applications especially in context of Cloud. In other words, this course will equip students with essential knowledge that is needed for building next-generation applications that are scalable and efficient and can process Big Data.

Course content:

The definition, characteristics, sources and challenges of big data; Big data management systems; The tools and software for analyzing big data; Big data ethics and security; Latest trend and research on big data; The definition, characteristics and benefits of cloud computing; Various types of cloud computing applications; Cloud computing service models; Tools and technologies used for the development and deployment of cloud computing; Security, management and best practices.IoT, Hybrid optimization models for real-world applications of IoTand big data analytics, Architectures and models for IoT networks using ML techniques;

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1		√			√				
CLO2						√			
CLO3						√			
CLO4								√	

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Store and manage big data from different field of inquiries	Create	Project Work
CLO2	Analyze big data using modern computing tools and services	Analyze	Assignments, Term and final examination
CLO3	Use cloud computing services effectively	Apply	Assignments, Term and final examination
CLO4	Maintain the ethics and security of data, s/he is working on	Apply	Project Work

DSA407– Data Security & Privacy

Course Rationale:

Today's technology-based world is floating on data. Data is available from numerous sources. While a well maintained and safe study on these data can be beneficial for the mass, use of these data in a wrong intention can be very dangerous, and even life threatening. Therefore, maintaining the privacy of the data owners and keeping their data in a secure and a safe place is vital. This course discusses about the security and privacy of data.

Course Content:

Data privacy laws; Legal requirements; Ethical foundations; Common security issues; Bias in algorithmic design; Balance of interests among individuals, government, and enterprises;Complicity; Bangladesh Perspectives;

Emerging technologies that may affect security and privacy concerns, issues related to development enterprise-level or national-level data security programs.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2								√	
CLO3					√				

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Understand the importance of security in the field of data sciences	Understand	Assignments, Term and final examination
CLO2	Identify any security flaws in a data policy	Evaluate	Assignments, Term and final examination, Project Work
CLO3	Work on improving current security and privacy measures in an educated & logical approach	Create	Assignments, Term and final examination, Project Work

DSA499– Data Science Project

Course Rationale:

The primary purpose of this research project is to apply the knowledge that the student gained during the coursework to a practical problem and to gain firsthand experience in doing research. The experience gained in the research project will help the students in securing positions in industries as researchers, analysts, and data scientists. Furthermore, this project also can help the students to get admissions for higher studies, such as M.Sc./PhD into national and international universities.

Course Content:

The project topic will be finalized by the supervisor. The project may be done individually or in a group of three to four students**.**

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1		√	√	√	√	√	√		
CLO 2	√								
CLO 3							√	√	
CLO 4								√	√

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Explain and analyze statistical and data-oriented problems independently and confidently.	Analyze	Project paper and presentation
CLO2	Develop critical thinking through observation and knowledge.	Evaluate	
CLO3	Develop communication skills in the scientific community	Examine	
CLO4	Apply their knowledge in different fields to contribute to society through research activities.	Apply	

STA430– Stochastic Processes

Course Rational:

Stochastic processes are ways of quantifying the dynamic relationships of sequences of random

events. Stochastic models play an important role in elucidating many areas of science. The course aims to introduce the fundamentals of stochastic models tools, methods andtheir applications.

Course Content:

A brief review of probability theory; Discrete Markov chains: Chapman-Kolmogorov equations, persistence and transience, generating functions, stationary distributions, reducibility, limit theorems, ergodicity; Continuous Markov processes: Poisson process, birth-death and branching processes, embedding of a discrete-time Markov chain in a continuous-time Markov processes; Stationary processes (autocorrelation function, spectral representation); Renewal processes, queues; diffusion processes, Wiener processes (Brownian motion) - Applications to finance (option pricing and the Black-Scholes theorem.)

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2			√						
CLO 3				√					
CLO 4					√				

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understand concepts and methods of stochastic modeling	Understand	Term and Final Examination
CLO 2	Compute probabilities of transition between states in Markov chains.	Analyze	Assignment, Term, and Final Examination
CLO 3	Identify classes of states in Markov chains and characterize the classes.	Analyze	Term and Final Examination
CLO 4	Solve problems in time-continuous processes and determine corresponding limit distributions.	Analyze	Term and Final Examination

STA432–Bayesian Statistics

Course Rationale:

The aim of this course is to introduce students to the Bayesian statistical modeling and inference and to the related computational strategies and algorithms. Thus, this course is important to the data analyst where Bayesian modeling and inference is needed.

Course Content:

Introduction, Comparison of frequentist and Bayesian statistics, One-parameter models, Simulation; Prior specification: Conjugate prior, Jeffereys prior; Empirical Bayes, brute-force posterior simulation; Basics of decision theory, multi-parameter models; Multivariate models; Linear regression, asymptotic approximation to posterior distributions; Hierarchical model; Gibbs sampling, Metropolis-Hastings algorithm; Theory of MCMC, Convergence diagnostics for MCMC; GLMM; latent variable model for ordinal data, Bayes factor; DIC, SSVS.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2				√					

CLO 3				√				
CLO 4			√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	have knowledge of basic concepts, philosophy and views in Bayesian statistics	Understand	Term and Final Examination
CLO 2	derive posterior distributions in simple cases and use predictive distributions	Analyze	Assignment, Term Examination
CLO 3	identify and formulate Bayesian statistical models for analysis and prediction	Analyze	Term and Final Examination
CLO 4	be able to use basic principles for decisions under uncertainty	Analyze	Term and Final Examination

DSA434–Time Series Analysis

Course Rationale:

This course aims to introduce students to a comprehensive set of tools and techniques for analyzing various forms of univariate and multivariate time series. After completing this course, students can apply key concepts of estimation and forecasting in a time series context.

Course Content:

Introduction to time series, Types of variation, The auto-covariance of a stationary time series; Box-Jenkins Model, the concept of a filter, root characteristic equation of time series; Estimation of the mean and the autocovariance; Prediction for stationary time series; The Wold's decomposition and Partial correlation;Partial autocorrelation, AR process, MA process, ARMA processes, Calculation of the ACVF, Prediction of an ARMA Process, co-integrated time series, ARIMA time series; Concept and properties of discrete random walks and random walks with normally distributed increments, both with and without drift; Dealing with multivariate time seriesdata – VAR model.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2				√					
CLO 3				√					
CLO 4			√						

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Define time series components.	Understand	Term and Final Examination
CLO 2	Construct a stationary time series model.	Analyze	Assignment, Term Examination
CLO 3	Construct nonlinear stochastic models.	Analyze	Term and Final Examination
CLO 4	Evaluate stationary in time series.	Analyze	Term and Final Examination

DSA436–Experimental Design
Course Rationale:

Experimental designs play an important role in process development and process troubleshooting in industry, business, agriculture and many others areas. Thus the course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain valid conclusions.

Course Content:
Overview and Basic Principles; Simple Designs and Analysis of Variance; Block Designs, Latin Squares and Related Designs; Full Factorial Designs; 2-level Full Factorial and Fractional Factorial Designs; Response surface methods and designs; Designs with Random Factors; Nested Designs and Split-plot Designs. example of real life application of these methods.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3				√					
CLO 4					√				

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understand the experimental methods and major experimental designs, and think critically about their proper applications.	Understand	Term and Final Examination
CLO 2	Formulate hypotheses that can be tested using experiments.	Understand	Term and Final Examination
CLO 3	Apply different types of experimental design.	Apply	Term and Final Examination
CLO 4	Explain the output of analysis of variance (ANOVA) from different design.	Analyze	Term and Final Examination

STA438– Biostatistics
Course rational:
This course provides an introduction to biostatistics and epidemiology to the student with minimal training in public health, the biomedical sciences, and statistics. It is important for the student to be able to identify causal factors and modes of transmission, with the assistance of statistical tools and biomedical information, and reflect the primary aim of epidemiology.
Course Content:
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**,** Inference Procedures for Exponential Distributions: One Parameter Exponential Distribution.Exponential Regression Model; Types of Epidemiologic Studies.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. Assignment and/or a mini project to be completed on the basis of the above topics by using software.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1		√							
CLO 2			√						
CLO 3				√					
CLO 4					√				
CLO 5							√		

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO1	Apply the theoretical foundations of probability theory and distribution theory	Analyze	Term and Final Examination
CLO2	Derive the theoretical mathematics of statistical inferences	Analyze	Term and Final Examination
CLO3	Perform survival model fitting and diagnosis	Apply	Term and Final Examination
CLO4	Interpret the results of statistical analysis to public health audience	Apply	Term and Final Examination
CLO5	Write scientific reports based on statistical analysis in public health.	Analyze	Term and Final Examination

STA440– Information Systems

Course rational:

This course introduces few information systems (Such as MIS and GIS) with basic levels of analysis.

Course content:

Introduction GIS; Applications and benefits; Methods for collecting, storing and managing geospatial data in different formats and systems; Analysis and visualization of such data; Use of scripting, automation and web databases to enhance GIS capabilities; Use of popular GIS software applications such ArcGIS; Introduction to MIS; Components and roles; Designing, implementing and evaluating an MIS; Different types of information systems used in businesses; Security and ethical issues; Introduction to Mobile Positioning Data (MPD) .

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1		√							
CLO2			√						
CLO3					√				
CLO4			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Collect & manage geospatial data	Apply	Project work
CLO2	Analyze geo-spatial data	Analyze	Assignments, Term and

			final examination
CLO3	Designing different business management systems	Apply	Project Work
CLO4	Analyze data from different business management systems	Analyze	Assignments, Term and final examination

ECO465– Basic Econometrics

Course Rationale:

The objective of this course is to prepare students for basic empirical work in economic data. Thus, the course is important for students who want to make a career as data analyst in applied economics and related fields.

Course Content:

This course focuses on OLS estimation, including two-variable regression, functional form, multiple regression, multicollinearity, heteroskedasticity and autocorrelation, specification errors, dummy variables, lagged variables, identification, and systems estimation.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2		√							
CLO 3	√								
CLO 4					√				
CLO 5						√			

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain /Level	Assessment Tool
CLO 1	Explain core concepts and methods in econometrics where the classical linear regression model gets more attention.	Understand	Term and Final Examination
CLO 2	Basic knowledge of how to detect and treat violations of the OLS method.	Understand	Term and Final Examination
CLO 3	Understand about nonlinear econometric models, Simultaneous equation models, Fixed Effects, Random Effects, and Dynamic Models.	Understand	Term and Final Examination
CLO 4	Apply appropriate econometric methods in various econometric data.	Apply	Term and Final Examination
CLO 5	Use statistical software to implement the various modes taught employing secondary data and demonstrate ability to analyze and assess empirical results.	Analyze	Term and Final Examination

CS410– Deep Learning

Course Rationale:

Deep learning methods use artificial neural networks to mimic the learning process of the human brain. This course covers advanced concepts, methods and applications of deep learning.

Course content:

The definition, scope and challenges of deep learning; Basic concepts and terminologies; Neural network basics; Various kinds of basic and advanced neural networks; Methods for evaluating and improving the performance and efficiency of neural networks; Various tools and software

used for facilitating the development and deployment of neural networks; Latest development in the field of deep learning.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2					√	√			
CLO3					√				

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Understand the working principles of basic and advanced neural networks	Understand	Assignments, Term and final examination
CLO2	Use computing tools to develop neural network-based learning models	Create	Assignments, Term and final examination, Project Work
CLO3	Evaluate performances of neural-network-based models	Evaluate	Assignments, Term and final examination

CS412– Data Visualization

Course Rationale:

This course provides different techniques and ways of presenting various types of data and outputs graphically with the aim to explore the data characteristics, test theoretical assumptions for analysis, and create interactive maps and dashboards.

Course content:

The value and purpose of data visualization; The principles and techniques of designing and evaluating a visualization; Various basic to advanced visualization techniques such as basic charts and graphs, graphs for- high-dimensional data, multivariate data, temporal and spatial data, data from analogue and digital devices; Network and relational graphs; Contour plot, surface plot, heatmap; Interactive dashboards; Use of tools and software for data visualization such as- R, Python, Tableau, PowerBI, or Jupyter; etc.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√	√							
CLO2						√			
CLO3			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning &assessmentstrategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Explore data by means of graphical methods	Evaluate	Assignments, Term and final examination
CLO2	Use modern computing tools to visualize data and analyses	Apply	Assignments, Term and final examination
CLO3	Display the outcomes in such a way that makes it easy for the reader to understand and creates correct intuition in the reader's mind on the study outcome	Evaluate	Assignments, Term and final examination

CS414– Cryptography and Blockchain

Course Rationale:

It is important to have knowledge and skills on cryptography, encryption technologies and blockchain technologies to develop, maintain and use a safe and secure data transaction and storage system.

Course Content:

Zero knowledge, Concurrency and protocol security, cryptographic game theory, public and private keys, digital signature, basic proof techniques, multi-party computation; Crypto-mining, hashing, proof of work, decentralized systems, consensus protocols, transaction integrity.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2					√				
CLO3		√							

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Understand cryptography and encryption techniques	Understand	Assignments, Term and final examination
CLO2	Apply cryptographic knowledge in digital data transaction to create safe and secure network	Apply	Assignments, Term and final examination, Project Work
CLO3	Maintain a blockchain based system	Apply	Assignments, Term and final examination, Project Work

CS416– Bioinformatics

Course rational:

This course aimed at statistical analysis of biological data, especially of molecular biology. This gives a foundation in both biological and computational aspects of this field as well as the ability to apply appropriate statistical methods to these data and interpret the results.

Course content:

The definition, scope and challenges of bioinformatics; The types and sources of biological data, such as DNA, RNA, proteins, genomes etc.; Basic concepts and terminology of molecular biology such as genes, transcription, translation, mutations, etc.; Data visualization; The methods and algorithms for analyzing biological sequences; The methods and algorithms for analyzing genomic and transcriptomic data.; The methods and algorithms for analyzing proteomic and metabolomic data; Use of databases and computer tools for such data; Application of machine learning techniques in bioinformatics.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1			√			√			
CLO2			√			√			
CLO3						√	√		
CLO4		√							

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Analyze transcriptomic data using modern computing tools	Analyze	Assignments, Term and final examination
CLO2	Analyze proteomic data using modern computing tools	Analyze	Assignments, Term and final examination
CLO3	Analyze genome sequence data using modern computing tools	Analyze	Assignments, Term and final examination, Project Work
CLO4	Visualize biological data	Apply	Assignments, Term and final examination

CS418– Machine Learning for Health Sciences

Course Rationale:

This course provides applications of statistics, big data analytics and machine learning methods in the field of health and medicine.

Course Content:

An introduction to the application of machine learning methods to problems in health data; Exploratory data analysis, summarizations and visualizations for public health and health service system data; Risk stratification, disease progression modeling. Drug discovery, precision medicine; Disease discovery; Developing relations between diseases, symptoms, diagnosis and recovery; Prediction and forecasting based on public health data; Strategies and challenges in machine learning in health sciences.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2			√						
CLO3				√					

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Understand the opportunities of data analytics in health sciences	Understand	Assignments, Term and final examination
CLO2	Analyze health related data	Analyze	Assignments, Term and final examination
CLO3	Model disease and drug progression	Apply	Assignments, Term and final examination, Project Work

CS420– Machine Learning for Cyber Security

Rationale of the Course:

The increasing complexity and frequency of cyber threats and attacks require innovative solutions to safeguard digital systems and data. This course aims to provide students with a strong foundation of machine learning applications in the field of cyber security. By understanding the underlying principles of machine learning and its potential to analyze large datasets, students will be equipped to develop intelligent systems capable of identifying and mitigating cyber security risks.

Course Content:

Machine learning and cyber security, exploring cyber threats, attack vectors, and the value of data-driven security strategies;Dimensionality reduction tailored to cyber security data;Data preprocessing techniques for cyber security; Intrusion detection and anomaly detection, anomaly

detection using machine learning algorithms;Malware detection and analysis, behavioral analysis, classification methods, and case studies on detecting evolving malware;Threat intelligence and predictive analytics, applying machine learning to threat intelligence, predictive models for anticipating security incidents, and strategies for integrating threat intelligence into security operations; Security analytics and visualization, interactive dashboard creation, and showcasing real-world security analytics applications;Ethical considerations associated with machine learning in cyber security, data protection in security analytics.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1		√							
CLO2			√						
CLO3			√		√				
CLO4									

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Comprehend the role of machine learning in the context of cyber security, recognize various types of cyber threats, and articulate the significance of data-driven security strategies.	Lecture, Class Discussion, Discussion Outside Class with Instructor	Formative: Homework, Workshop, Summative: Examination
CLO2	Apply the basics of supervised, unsupervised, and reinforcement learning to cyber security scenarios, implement feature engineering and dimensionality reduction techniques tailored to security data, and employ appropriate evaluation metrics to assess model performance.	Lecture, Class Discussion, Discussion Outside Class with Instructor	Formative: Homework, Workshop, Pitching, Presentation Summative: Examination
CLO3	Demonstrate proficiency in data collection, cleaning, and transformation techniques specific to cyber security, address challenges posed by imbalanced datasets and missing data, and perform exploratory data analysis to gain insights into security-related data.	Lecture, Class Discussion, Discussion Outside Class with Instructor	Formative: Homework, Pitching Summative: Examination
CLO4	Develop intrusion detection systems utilizing machine learning components, construct anomaly detection models for network traffic analysis, identify malware using machine learning techniques, and utilize threat intelligence and predictive analytics to anticipate cyber security incidents, integrating these insights into security operations effectively.	Lecture, Class Discussion, Discussion Outside Class with Instructor	Formative: Homework, Workshop, Presentation Summative: Examination

BUS420– Business Intelligence

Course Rationale:

This is an applied course focusing on the applications of statistics, big data analytics and machine learning methods to understand the business environment, consumer and market behavior.

Course Content:

Collecting, integrating, analyzing and presenting business data; Data warehousing; Visualization and dashboards of business data; Content Management; Knowledge Management; Social media, big data and data mining; Strategic Approach to BI; Applications of regression, time-series, test of hypothesis, decision theory using software and machine learning tools in business decision making and forecasting.

Mapping of course learning outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	√								
CLO2			√	√					
CLO3			√						

Mapping of the course learning outcomes (CLOs) with the teaching-learning & assessment strategy

CLOs	CLO description	Domain/Level	Assessment tool
CLO1	Explore the dynamics of business data	Understand	Assignments, Term and final examination
CLO2	Analyze & model business and consumer data	Analyze	Assignments, Term and final examination, Project Work
CLO3	Make comparable business decisions	Analyze	Assignments, Term and final examination

FIN7430– Foundation of Financial Technology

Course Rationale:

This is an innovative course designed to develop skills among students for a potential career in the fin-tech industry, combining financial theory, big data management, analytics, and data visualization with a view to supporting large and small companies, which are developing solutions through the use of technology.

Course Content:

Fin-Tech opportunities to improve the financial system, Recent developments of Fin-tech in Bangladesh and across the globe, Current Major areas of Fin-Tech (Financial institutions, Capital market, e-retailers etc.), Potential issues with Fin-Tech and future prospects, Fin-tech, Crypto and AI, Changing Structure of the Financial Ecosystem, Financial Innovation, and Inclusion, of Blockchain and Crypto-currency (digital currency) Technologies, Continuing Evaluation of Crypto-assets / digital-assets technology, Fin-tech in a Global Setting, Fin-tech and Government Regulation

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3				√					
CLO 4				√					

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain /Level	Assessment Tool
CLO 1	Demonstrate an understanding of recent developments of Fin-tech.	Understand	Term and Final Examination
CLO 2	Demonstrate a solid understanding of the wider range Fintech services in the marketplace, new services, and products, often mobile and disruptive, blockchain, smart contract, crypto-currency, crypto-assets, and AI, cutting-edge developments in banking, financial markets, and entrepreneurial fields.	Understand	Assignment, Term Examination
CLO 3	Apply and analyze social and distributional issues around new Fin-tech and the related ecosystem through technological innovation and market penetration.	Analyze	Term and Final Examination
CLO 4	Able to critically analyze and apply Ethical issues of Fin-tech, relevance to new Fin-tech in a global	Analyze	Term and Final Examination

	perspective, the entrepreneurial approach of innovation, and existing and emerging rules and regulations of financial markets in the context of local, regional, and global.		

FIN7431– Systems Analysis and Design

Course Rationale:

A practical area of the information systems discipline called systems analysis and design necessitates mastery of both established concepts and principles and cutting-edge tools and methodologies.

Course Content:

This course familiarizes the students with the role that a system analyst can play in modern organizations. Knowledge about project management and different phases of system development, from basic information gathering to full-scale implementation and maintenance, is necessary for the implementation of new financial products and services in organizations as well as for introducing changes to enable such organizations to survive in the new global competitive business world.

Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	√								
CLO 2	√								
CLO 3				√					
CLO 4			√						

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	CLO Description	Domain/Level	Assessment Tool
CLO 1	Understand current information systems and user's requirements in a systematic approach.	Understand	Term and Final Examination
CLO 2	Understand user requirements, suggest and design new information systems that solve the current problems and meet user's requirements.	Understand	Assignment, Term Examination
CLO 3	Apply proper techniques and methodologies throughout the development process.	Analyze	Term and Final Examination
CLO 4	Plan and undertake a major individual project and prepare and deliver coherent and structured verbal and written technical reports.	Analyze	Term and Final Examination

N.B.: The contents of the GED courses are not given here as these courses are taught in different departments of East West University.