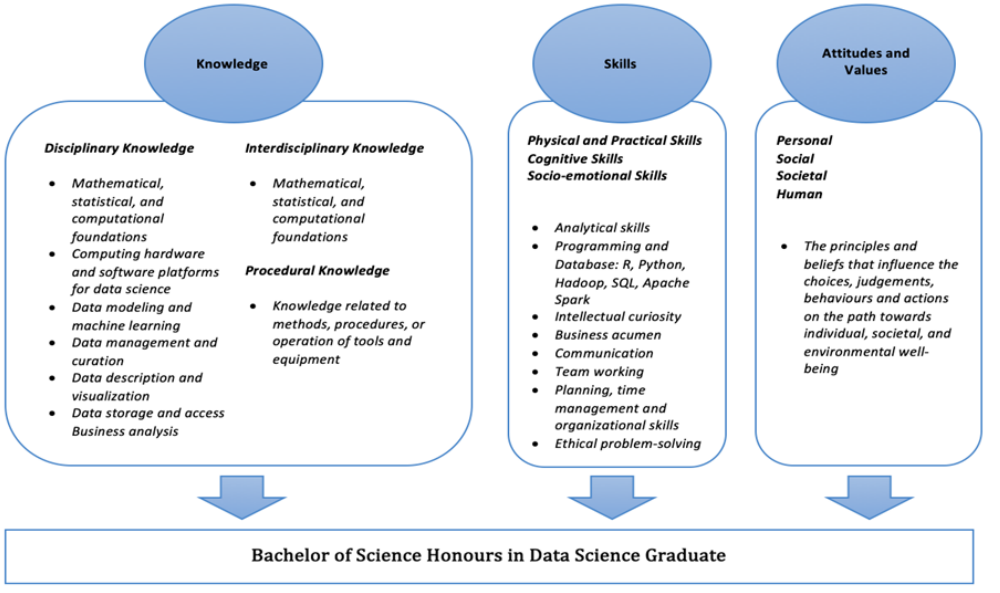
DEPARTMENT OF DATA SCIENCE

Degree Programme

Bachelor of Science Honours in Data Science [BScHons (DS)]

Graduate Profile



Guidelines for course codes and credits

- Each course code consists of four digits together with the prefix (alphabet letters)
- Prefix alphabet letters denote the abbreviation to the name of degree Programme (DS)
- The first digit of each course code is the corresponding semester of study (1-8).
- Second digit represents the revision of the subject, and it will increment if the subject is revised.
- Third and fourth digits represent the subject code

Example: The course code of DS1101 denotes the following;

Abbreviated name of degree Programme	Semester	Revision Number	Subject Code
DS (Data Science)	1	1	01

Note: There are no spaces or special characters in the course code.

Summary of the Courses

Table 1: Courses offered in the Semester I			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS1101	Introduction to Data Science	1	Compulsory
DS1102	Programming Fundamentals	2	Compulsory
DS1103	Calculus	2	Compulsory
DS1104	Introduction to Statistics	2	Compulsory
DS1105	Database Management Systems	2	Compulsory
DS1106	Computer System Organization	2	Compulsory
DS1107	Data and Society	1	Compulsory
DS1108	Web Programming I	2	Compulsory
DS1109	Communication Skills I	-	Compulsory (Non-GPA)
DS1110	Academic Integrity	-	Compulsory (Non-GPA)
DS-EGP-1101	General English I	-	Compulsory (Non-GPA)
	Total	14	

Table 2: Courses offered in the Semester II			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS2101	Operating Systems	2	Compulsory
DS2102	Data Structures	2	Compulsory
DS2103	Linear Algebra	2	Compulsory
DS2104	Object Oriented Programming	2	Compulsory
DS2105	Capstone Project in Data Science I	2	Compulsory
DS2106	Analysis of Algorithms	2	Compulsory
DS2107	System Analysis and Design	2	Compulsory
DS2108	Data Pre-Processing	1	Compulsory
DS2109	Communication Skills II	-	Compulsory (Non-GPA)
DS-EGP-1201	General English II	-	Compulsory (Non-GPA)
	Total	15	

Table 3: Courses offered in the Semester III			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS3101	Probability Theory	2	Compulsory
DS3102	Regression Analysis	2	Compulsory
DS3103	Multivariate Calculus	2	Compulsory
DS3104	Real World Analytics	1	Compulsory
DS3105	Computer Networking	2	Compulsory
DS3106	Data Warehousing	2	Compulsory

DS3107	Web Programming II	2	Compulsory
DS-EAP-2101	Academic English I	-	Compulsory (Non-GPA)
	Total	13	

Table 4: Courses offered in the Semester IV			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS4101	Advanced Database Management Systems	2	Compulsory
DS4102	Scientific Writing & Documentation	1	Compulsory
DS4103	Software Engineering	2	Compulsory
DS4104	Data Visualization	2	Compulsory
DS4105	Capstone Project in Data Science II	2	Compulsory
DS4106	Applied Data Mining	2	Compulsory
DS4107	Social and Professional Issues in Computing	2	Compulsory
DS4108	Business Intelligence	2	Compulsory
DS4109	Discrete Mathematics	2	Compulsory
DS4110	Artificial Intelligence	2	Compulsory
DS-EAP-2201	Academic English II	-	Compulsory (Non-GPA)
	Total	19	

Table 5: Courses offered in the Semester V			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS5101	Semantic Web	2	Compulsory
DS5102	Time Series Analysis and Forecasting	2	Compulsory
DS5103	Information Security	2	Compulsory
DS5104	Machine Learning	2	Compulsory
DS5105	Linear Programming	2	Compulsory
DS5106	Graph Theory	2	Compulsory
DS-EBP-3101	Business English	-	Compulsory (Non-GPA)
Students should select courses covering 04 Credits from the following elective courses			
DS5107	Image Processing	2	Elective
DS5108	Mobile Computing	2	Elective
DS5109	Data Science for Bioinformatics	2	Elective
DS5110	Human Resource Management	2	Elective
DS5111	Parallel and Distributed Computing	2	Elective
	Total (Compulsory + Electives)	16	
Table 6: Courses offered in the Semester VI			
Course Code	Course Title	No of	Compulsory

		Credits	or Elective
DS6101	Introduction to Deep Learning	1	Compulsory
DS6102	Bayesian Learning and Graphical Models	2	Compulsory
DS6103	Mathematical Optimization	2	Compulsory
DS6104	Industrial Training	6	Compulsory
Students should select courses covering 02 Credits from the following elective courses			
DS6105	Web Services	2	Elective
DS6106	Cloud Computing	2	Elective
DS6107	Business Process Management	2	Elective
DS6108	Software Quality Assurance	2	Elective
DS6109	Fraud and Anomaly Detection	2	Elective
	Total (Compulsory + Electives)	13	

Table 7: Courses offered in the Semester VII			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS7101	Research Method	2	Compulsory
DS7102	Advanced Deep Learning	2	Compulsory
DS7103	Emerging Trends in Data Science	1	Compulsory
DS7104	Numerical Methods	2	Compulsory
DS7105	Natural Language Processing	2	Compulsory
Students should select courses covering 04 Credits from the following elective courses			
DS7106	Entrepreneurship and Innovation	2	Elective
DS7107	Internet of Things	2	Elective
DS7108	Design Patterns and Anti-patterns	2	Elective
DS7109	Ontology Engineering	2	Elective
DS7110	Blockchain and Cryptocurrency	2	Elective
	Total (Compulsory + Electives)	13	

Table 8: Courses offered in the Semester VIII			
Course Code	Course Title	No of Credits	Compulsory or Elective
DS8101	Research Project in Data Science	8	Compulsory
DS8102	Information Retrieval and Web Analytics	2	Compulsory
DS8103	Reinforcement Learning	2	Compulsory
DS8104	Computational Intelligence	2	Compulsory
DS8105	Business Analytics and Applications	1	Compulsory
Students should select courses covering 02 Credits from the following elective courses			
DS8106	Geographical Information Systems	2	Elective
DS8107	Digital Forensics	2	Elective
DS8108	Business Process Simulation	2	Elective
DS8109	Robotics	2	Elective
	Total (Compulsory + Electives)	17	

Summary of Credits Required

	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI	Semester VII	Semester VIII
Credited and Compulsory courses	14	15	13	19	12	11	09	15
Credited and Elective courses	-	-	-	-	04	02	04	02
Credited, Compulsory and Non-GPA Courses	06	04	02	02	02	-	-	-
Total credits	29		32		29		30	
Total credits for the degree programme	120							

Detailed Syllabus

N.B.

TH - Theory
PRS - Practical
IFV - The department organizes the field visit relevant to the particular subject area.
WS - The department organizes workshops relevant to a particular course unit.
THS- Thesis
PR - Report on a research and /or development work

Semester I				
DS1101	Introduction to Data Science	TH	-	-
Overview of Data Science. Data Collection, Integration, Management, Modeling, Analysis, Visualization, Prediction, Abnormalities in data. Informed decision making. Data science project lifecycle. Data products for business applications. Introduction to data security and data privacy.				

DS1102	Programming Fundamentals	TH	PRS	-
Introduction: Relationship between computers and Programmes, Basic principles of computers, File systems, Using the Python interpreter, Introduction to binary computation -- Input / Output. Data types and control structures: Operators (unary, arithmetic, etc.), Data types, variables, expressions, and statements, Assignment statements, Strings and string operations. Control Structures: loops and decision. Modularization and Classes: Standard modules, Packages, Defining Classes, Defining functions, Functions and arguments (signature). Data structures: Data Structures (array, List, Dictionary, Tuples, and Sets). Exceptions: Testing, Error processing: Exception Raising and Handling.				

DS1103	Calculus	TH	-	-
The real number system: Real number system as a complete ordered field, Complex number system, Neighbourhoods. Sequences and limits: Definition of convergence, Limit theorems, Monotonic sequences, Monotone convergence theorem, Algebra of limits. Limits and continuity of real valued functions: Limit of a function, Algebra of limits, Continuity of a function, Properties of continuous functions, Sequential criterion for limits and continuity, Intermediate value theorem and extreme value theorem. Differentiability of real valued functions: The definition of the derivative, Algebra of derivatives, Product and quotient rules, Rolle's theorem, Mean-value theorem and its applications, L'Hospital's rule. Applications of the derivative: Optimization problems, Related rates problems, Graph sketching.				

DS1104	Introduction to Statistics	TH	-	-
Exploring data using charts: bar chart, pie chart, multiple bar chart, stack bar chart, histogram, scatter plot. One-way, Two-way cross classification tables, Central tendency measures, dispersion measures: range, IQR, variance, and standard deviation. Box plot and its application, Correlation: Pearson correlation and Spearman rank correlation and their application, Report writing based on the exploratory data analysis outcomes.				

DS1105	Database Management Systems	TH	-	-
Introduction to Databases: Definition of the database, database system, data models, database applications. Database system architecture, Characteristics of database approaches. Database development process. Data models. Relational model. ER model. Schema Mapping. Designing: Logical design: Relational database model, Logical view of data, keys, Integrity rules, Normalization. Relational algebra: Introduction, Selection & projection, Set operations, Renaming, Joins, Division, Syntax, Semantics, Operators, Grouping & ungrouping, Relational, Triggers.				

DS1106	Computer System Organization	TH	-	-
Basic concept and computer evolution: Organization and Architecture, The evolution of the Intel x86 Architecture, Embedded Systems, ARM architecture. Computer Performance Issues: Multicore, MIC and GPGPUs, Basic Measures of Computer Performance, Benchmark and SPEC. Computer Function and interconnection: Computer Bus Interconnection, Point to Point Interconnection. Computer Memory System: Cache Memory Principles, Semiconductor main memory, External memory. Input/output: External Devices, I/O Modules, Interrupt Driven I/O, Programmed I/O, I/O channels and processors, External Interconnection Standards. Arithmetic and Logic: number system, Integer Representation, Floating Point representation, Digital logic, Combinational Circuits, Sequential Circuits, Programmable Logic Devices. The Central Processing Unit: Machine Instruction Characteristics, Addressing Modes, Assembly language, Processor, Instruction Level Parallelism and Superscalar Processor. Parallel Organization: Parallel processing, Multicore computers, General purpose graphic processing unit.				

DS1107	Data and Society	TH	-	-
Introduction to the course: Platforms, Data and the Digital Economy. The Digitization of Everyday Life: Sensors, Signals and Devices Seminar: Data politics and the politics of data. Digital Platforms. Platform Ecosystems. Social Media: Privacy and Information Passing. Sociological Inquiry and Big Data.				

DS1108	Web Programming I	TH	PRS	-
Internet fundamentals. HTML. Cascading Style Sheets (CSS). Client-side Scripting: JavaScript, Typescript and pug, AJAX. Introduction to UI Frameworks with responsive front-end design. Introduction to Browser based developer tools. Practical: Hands on experience in web tools.				

DS1109	Communication Skills I	TH	-	-
Introduction to Communication: Purpose of Communication; Process of Communication; Importance of Communication in Business; Differences between Technical and General Communication; Barriers to Communication; Measures to Overcome the Barriers to Communication, Types of Communication: Types of Communication; Verbal Communication-Importance of verbal communication-Advantages of verbal communication- Advantages of written communication; Significance of Non-verbal Communication, Listening Skills: Listening Process;				

Classification of Listening; Purpose of Listening; Common Barriers to the Listening Process; Measures to Improve Listening; Listening as an Important Skill in Workplace, Language for Communication: Language and Communication; General Principles of Writing; Improving Writing Skills; Essentials of good style; Expressions and words to be avoided; Grammar and Usage, Communication in Organizations: Internal Communication; Stakeholders in Internal Communication; Channels of Internal Communication; External Communication; Stakeholders in External Communication; Channels of External Communication, Communication Network: Scope and Types of Communication Network; Formal and Informal Communication Network; Upward Communication; Downward Communication; Horizontal Communication; Diagonal Communication, Writing Business Letter: Importance of Business Letters; Difference between Personal and Business Letters; Structure and Format of Business Letters; Types of Business Letters.

DS1110	Academic Integrity	TH	-	-
Introduction to academic integrity, Academic integrity policies, Plagiarism, collusion and contract cheating, putting academic integrity into practice, Research ethics, Citing and referencing, Reading and Note-making, Critical Thinking				

DS-EGP-1101	General English I	TH	-	-
Refer English Curriculum (Page 88 & 89)				

Semester II				
DS2101	Operating Systems	TH	PRS	-
Operating Systems Overview (Historical development, Operating system objectives and functionalities, Major achievements). Process & Thread Management (Process concepts, Thread concepts, Descriptions, structures, and controls, Multiprocessors and Multi Thread programming). CPU Scheduling. Concurrency Control (Mutual exclusion, Synchronization, Deadlock, Starvation). Memory Management (Multiprogramming and partitions, Paging and segmentation, Virtual memory, Demand paging, Page replacement algorithms). I/O & File Management (I/O devices, Disk scheduling, File organization, Directory structures). Case Studies.				

DS2102	Data Structures	TH	-	-
Introduction to Data structures: Abstract Data Types and applications, Time and space requirements of algorithms. Arrays: Representation and implementation, Polynomials, Sparse matrices, String-pattern Matching. Stack and Queues: Representation and implementation, multiple stacks and queues, recursion in stacks. Linked Lists, Representation and implementation, Doubly linked list, Circular linked list. Trees: Binary tree representation, traversals and applications, Threaded binary trees, Binary Search Trees, AVL Trees. Graphs: Graph representations, Graph Traversals: Depth-first search, Breadth-first search, Weighted Graphs. Priority Queues: Heap Structures, Binomial Heaps, Leftist Heaps.				

DS2103	Linear Algebra	TH	-	-
Vector Spaces: Vector spaces and Subspaces, Linear Independence, Basis, and Dimension, Linear transformations, applications. Solving Systems of linear equations: Elementary row operations, Elementary matrices; Matrix algebra, the				

inverse of a matrix, The LU factorization, applications. Determinants: Determinants of a matrix, properties of determinants, Cramer's rule, Eigenvalues and Eigenvectors, Similarity and Diagonalization, applications. Inner Product Spaces: Inner Product, Norm of vector, Inner product spaces, The Gram-Schmidt Process, The QR Factorization Least-Squares Problems, The Singular Value Decomposition, applications.

DS2104	Object Oriented Programming	TH	PRS	-
Fundamentals of Object-Oriented Programming; Classes & Objects. Data Abstraction. Information Hiding & Encapsulation. Methods: Void methods, return methods, argument passing. Inheritance. Polymorphism: Method overloading and method overriding. Abstract Classes. Exception Handling. Files & Database connections.				

DS2105	Capstone Project in Data Science I	-	WS	PR
Capstone project may involve investigation of data engineering tools, installation, and configuration. The students will apply their knowledge on relational data model and management, NoSQL data model and management and data distribution. Moreover, the students will utilize their knowledge on data distribution, data processing techniques such as cleaning, transforming, and enriching data. In addition, students will acquire the skills in using Big data platforms.				

DS2106	Analysis of Algorithms	TH	-	-
Introduction to algorithms. Basic algorithmic analysis. Simple Searching Algorithms. Simple Sorting Algorithms. Recursion. Advanced Searching Algorithms. Advanced Sorting Algorithms. Graph Algorithms -Breadth first search, Depth first search. Dynamic Programming. Greedy algorithms.				

DS2107	System Analysis and Design	TH	-	-
System Analysis Fundamentals: Fundamentals System Analysis and Design (SA&D) concepts, Roles of system analyst, System development life cycle, depicting system graphically, determining feasibility, activity planning and control. Evolution of software development models. Information requirements analysis. Process requirements analysis. The essentials of design. Deployment and maintenance.				

DS2108	Data Pre-Processing	TH	PRS	-
Introduction to Data Preprocessing: What is data preprocessing?, What is dirty data?, Structuring Data, Overview of Data Cleansing. Data Quality: Data Quality, Data Quality Challenges, Raw Files and File Formats, Structured Data, Finding Data Sets, Loading Data into programming language. Summarizing Data with Statistics: Review of Basic Statistics, Summarizing Data. Data Visualization: Introduction to Data Visualization, EDA and CDA, Creating a Histogram, Box Plots, Bar Graphs, Other Graphs.				

DS2109	Communication Skills II	TH	-	-
Writing Memos, Circulars and Notices: What is a Memo?- Principles of précis writing- Approaches to memo writing- Characteristics of a memo- Guidelines for				

writing memos- Language and writing style of a memo- Format of a Memo; Circulars Guidelines for writing a circular- Languages and writing style of a circular- Format of a circular; Notices- Purpose- Format- Important points to remember while writing a notice. Report Writing: Features of Writing a Good Report; Purpose of Report Writing; Difference between Business Report and Engineering Report-Characteristics of writing a good report-Importance of communication in report writing; Guidelines for Report Writing; Steps in Report Writing; Structure of Report; Types of Reports and Different Formats. Writing E-mail: Principles of E-mail; E-mail Etiquette; Overcoming Problems in E-mail Communication. Oral Communication Skills: Oral Business Presentation- Purpose –Audience Locale; Steps in Making a Presentation- Research and planning-Structure and style Preparation –Presentation; Delivering a Presentation. Meetings: Types of Meetings; Importance of Business Meetings; Different Types of Business Meetings; Conducting Meetings-Selecting Participants-Developing Agendas-Opening Meetings-Establishing ground rules for meetings-Time management Evaluations of meeting process-Evaluating the overall meeting-Closing meetings; Common Mistakes Made at Meetings. Reading Skills: Reading Skill; Purpose of Reading; Types of Reading; Techniques for Effective Reading. Employment Communication – Resume: Contents of Good Resume; Guidelines for Writing Resume; Different Types of Resumes; Reason for a Cover Letter to Apply for a Job-Format of Cover Letter; Different Types of Cover Letters. Employment Communication – Job Interview: Importance and Factors Involving Job Interview; Characteristics of Job Interview; Job Interview Process; Job Interview Techniques- Manners and etiquettes to be maintained during an interview; Sample Questions Commonly asked During Interview.

DS-EGP-1201	General English II	TH	-	-
Refer English Curriculum (Page 88 & 89)				

Semester III				
DS3101	Probability Theory	TH	-	-
Introduction to set theory. Introduction to probability, marginal probability, conditional probability. Random variables. Discrete and continuous probability distributions: Discrete Uniform, Bernoulli, Binomial, Poisson, Continuous Uniform, normal, exponential. Introduction to t- distribution, F-distribution and Chi-square distribution.				

DS3102	Regression Analysis	TH	-	-
Simple linear regression model. OLS and ML approaches to estimate the regression parameters. Inference about regression parameters. Model validation. Handling qualitative predictors. Lack-of-fit of the model. Model selection procedures.				

DS3103	Multivariate Calculus	TH	PRS	-
Differential calculus of functions of several variables: Limits and continuity, partial derivatives, the derivative of a multivariable function, chain rule, extrema of multivariable functions, Lagrange multipliers. Integration of functions of several variables: The Jacobian, double and triple integrals, change of variables, spherical and cylindrical coordinate systems. Special functions: Beta, gamma, Bessel,				

Legendre functions, Fourier series and its applications, integral transformations. Applications of multivariate calculus in data science: Multivariate calculus in machine learning, explanation of calculus in gradient descent.

DS3104	Real World Analytics	TH	PRS	-
Identification of data to be collected to solve a real-world problem. Data source authentication. Identifying the data types. Data validation. Organizing data, Transforming data. Linearization and Regularization. Overfitting. Bias and Variance Trade-off. Interpretability methods in the context of the framework.				

DS3105	Computer Networking	TH	PRS	-
Device to Device Communication Architectures: Algorithms & protocols designed for MANET, mesh, cellular & opportunistic networks. Students will read several classic research papers to understand the design choices & vision. Content based Network Architectures: Principles of data dissemination, aggregation & caching that are applied to sensor networks, Internet of Things & other content-based paradigms. Students will survey recent research publications on opportunistic networks & next generation content-based networking ideas. Applications: P2P, Social Networks, Cloud computing applications will be discussed for the IP network & similar applications for next generation networks. These discussions will be mainly led by students & moderated by the instructor. Simulation & Experimentation: Introduction to performance analysis of new networking ideas using the Network Simulator -v3 (ns3), Click Modular Router & the GENI testbed. Students will complete lab exercises that demonstrate various capabilities of the aforementioned tools. Practical: Hands on experience with related latest tools				

DS3106	Data warehousing	TH	-	-
Data Warehousing concepts. Comparing operational database to data warehouse. Data Warehousing system and components. Data transformation process functions. Online analytical processing (OLAP) and OLAP tools. Data Warehousing applications. Data Mining concepts and techniques.				

DS3107	Web Programming II	TH	PRS	-
Introduction to PHP, server side of scripting language. Handling form input with PHP, Introduction of OOP using PHP, User authentication. PHP Basic Constructs - Variables and data types, Expressions and perators, Conditional statements, Functions, Arrays and Objects, PHP $_GET, PHP $_POST. PHP cookies, PHP sessions. What's a database and what's an RDBMS?, Introduction to SQL. Relational Database concepts, Designing a web database. Primary keys in database tables, SQL statements: SELECT, INSERT, UPDATE and DELETE. Introduction to PHPMyAdmin. Creating a database in PHPMyAdmin. Accessing a database through PHP. Inserting data into the Database, Retrieving data from the Database, Using sub queries, Updating, adding and deleting records. Accessing MYSQL database from the web with PHP, Web database architecture, Querying the database from the web. Practical: Hands on experience in web development tools.				

DS-EAP-2101	Academic English I	TH	-	-
Refer English Curriculum (Page 88 & 89)				

Semester IV				
DS4101	Advanced Database Management Systems	TH	PRS	-
Database Design & Implementation: Relational Database Design, Database Implementation & Tools, Advanced SQL, Database System Catalog. DBMS Advance Features: Query Processing & Evaluation, Transaction Management & Recovery, Database Security & Authorization. Distributed Databases: Enhanced Database Models, Object Oriented Databases, Database & XML. Emerging Trends & Example of DBMS Architecture: Emerging Database Models, Technologies & Applications, Big data. Practical: Advanced SQL: Temporary table, Views, Stored procedures, Stored function & Triggers.				

DS4102	Scientific Writing and Documentation	TH	-	-
The nature of scientific writing; the scientific paper as argument. Writing proposals (Kinds of proposals, Standard formats for proposals, etc.). Strategies for making the proposal persuasive. Writing lab reports, project reports, and journal articles. Standard formats for research reports. Principles of structuring the report. Strategies for presenting data logically and persuasively. Writing abstracts (Kinds of abstracts; structuring the abstract, Strategies for making the abstract concise, specific, and detailed). Academic writing (research significance, flow, making claims and argumentation model). Maintaining objectivity. Using jargon, Presenting equations. Rhetorical principles and conventions of presenting data graphically. Documenting the scientific paper. Presenting scientific material to a lay audience. Ethics and Plagiarism.				

DS4103	Software Engineering	TH	-	-
Software Engineering concepts. Introduction to Software engineering frameworks. Requirements & Specification. Software Design. Software implementation. Software Testing & Quality Assurance. COTS & Reuse. CASE Tools. Software metrics & Reliability Assessment. CMMI. Team Organization & people management. Software Estimation. Software Maintenance. Software evolution.				

DS4104	Data Visualization	TH	PRS	-
Overview of Data Visualization. The Shapes of Data (Loading and Parsing Data with visualization libraries). Marks and Channels (Encoding Data with Marks and Channels). Visualization of Spatial Data, Networks and Trees. Using Color and Size in Visualization. Interaction Techniques. Multiple linked Views (Small Multiplies, Linked Highlighting with Brushing). Data Reduction (Histograms, Aggregating data, Hexbin Mapping, Cross- filtering).				

DS4105	Capstone Project in Data Science II	-	WS	PR
Capstone project II may involve investigation of data analysis and visualization techniques. This includes understanding the real-world problem, understanding the data set, data preparation, data modeling, validating, visualizing, and interpreting results. At the end of the year students will submit a progress report including the status of key stages of the project and results. Students will also rehearse a presentation for their mentor to practice for the end of programme presentation that will take place at the end of the second year.				

DS4106	Applied Data Mining	TH	PRS	-
Clustering Algorithms: K-mean, Agglomerative algorithm. Classification Algorithms: Decision Tree, Support Vector Machine. Association rule mining. Topic extraction. Practical: Implementation of datamining algorithms using python and Weka tools.				

DS4107	Social and Professional Issues in Computing	TH	-	-
History of computing, social context of computing. Methods & tools of analysis: consequence, duty and right based ethical theories. Professional & ethical responsibility. Risks & liability of computer-based systems. Intellectual property, privacy & civil liberties. Computer crime, customs & law. Economical issues in computing. Philosophical frameworks.				

DS4108	Business Intelligence	TH	-	-
Decision Support Systems and Business Intelligence: Business Environment Factors (markets, consumer demands, technology, and societal, etc.), Decision Support Frameworks (Degree of Structuredness vs. Types of Control), Automated Decision Making, Evolution of BI Capabilities, DSS & BI Architectures, Styles and Benefits of BI, Elements of a Work Systems, Major Tool Categories for Management Support Systems. Decision Making, Systems, Modeling, and Support: Introduction to Decision Making Disciplines, Characteristics of Decision Making and Decision Styles, Types and Benefits of Decision-Making Models, Decision-Making Process, New Technologies to Support Decision Making, Key Data Issues and Key Ingredients of Data (Information) Quality Management. Decision Support Systems Concepts, Methodologies, and Technologies: DSS Characteristics and Capabilities, DSS Classifications, Major DSS Components and Web Impacts, Future/current DSS Developments. Emerging Trends and Impacts: RFID and BI (RFID for BI in Supply Chain, RFID + Sensors for Better BI, etc.), Reality Mining and Virtual Worlds in BI applications, Web X.0 Revolutions, Virtual (Internet) Communities and Types, Online 62 | P a g e Social Networking and Social Network Analysis, Implications of Business and Enterprise Social Networks, Cloud Computing and BI, Issues of Legality, Privacy and Ethics. Collaborative Computer-Supported Technologies and Group Support Systems: Why (business) collaboration is difficult?, Time/Place Communication Framework, Groupware for (business) collaboration, Group Support Systems and Important Features, GSS Enabling Technologies, Collaborative Planning, Forecasting, and Replenishment (CPFR) and Collective Intelligence, Introduction to Taxonomy of Collective Intelligence.				

DS4109	Discrete Mathematics	TH	-	-
Theory and Logic: Fundamental concepts (set inclusion-exclusion and equalities), Functions (injective, surjective, bijective) and Relations, Equivalence relations and Equivalence classes, Countable, uncountable and well-ordered sets, Axiom of choice, Zorn's Lemma. Graph theory: Types of graphs, Isomorphism of graphs, Matrix representation of graphs, Eulerian and Hamilton graphs, Tree, spanning trees, Breath-first and Depth first algorithms, Kruskal's and Prim's algorithms, Directed graphs, vertex/edge connectivity, Network flow Applications. Counting: Different ways of counting, Double counting, Pigeonhole principle, Recurrence				

relations and their solutions, Modeling with recurrence relations, Generating functions.

DS4110	Artificial Intelligence	TH	-	-
Introduction: Practical examples of Artificial Intelligence, Intelligent Agents, Environments, Intelligent behaviour, Rational behaviour & Turing test. Problem solving by Searching: Problem-Solving Agents, Uninformed Search Strategies, Informed (Heuristic) Search Strategies. Local search and optimization algorithms: Hill climbing search, Simulated annealing, Local beam search, Genetic algorithms, searching in different environments, adversarial search. Planning: Classical planning, planning as state-space search. Learning Methodologies: Learning by Analysing Difference, by Recording Cases, by Correcting Mistakes, by Building Multiple models, by Building Identification Tree. Knowledge representation: Ontology engineering, Categories and objects, events. Natural Language Processing: Language models, Text classification, Information retrieval, Information extraction.				

DS-EAP-2201	Academic English II	TH	-	-
Refer English Curriculum (Page 88 & 89)				

Semester V				
DS5101	Semantic Web	TH	-	-
Introduction to semantic web. Data model: Extensible Markup Language (XML), Web Data Management with XML, XPath and XQuery. eXtensible Stylesheet Language Transformations (XSLT). Web Data Semantics and Integration: RDF, RDF2, OWL, OWL2, Ontologies -1, Ontologies -2. Introduction to SWRL.				

DS5102	Time Series Analysis and Forecasting	TH	-	-
Descriptive methods, plots, smoothing. Differencing: autocorrelation function, the correlogram and variogram. Periodogram: Estimation and elimination of trend and seasonal components, Stationary processes. Modeling autoregressive moving average (ARMA) models: ARIMA Models Identification, Building ARIMA models, estimation and diagnostic checking, forecasting.				

DS5103	Information Security	TH	-	-
Fundamental aspects of security: CIA, security mindset, design principles, system/security life cycle. Security Implementation Mechanisms (Guards, Gates, Cryptography, steganography). Information Assurance Analysis Models (Threats, Vulnerabilities, Attacks, Countermeasures). Disaster and Recovery. Security Mechanisms: Cryptography, Authentication, Redundancy, Intrusion Detection. Operational Issues: Trends, Auditing, Cost-Benefit analysis, Asset Management, Standards, Enforcements, Legal Issues. Policy: Creation & Maintenance of Policies, Prevention, Avoidance, Domain, Integration. Attacks: Social Engineering, Denial of Service, Protocol Attacks, Active & Passive Attacks, Buffer Overflow Attacks, Malware. Forensics: Legal Systems, Digital Forensics, Rules of Evidence, Search & Seizure, Digital Evidence, Media Analysis.				

DS5104	Machine Learning	TH	-	-
Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, VapnikChervonenkis dimension. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks. Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles. Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov nets for representing dependencies. Language Learning: Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.				

DS5105	Linear Programming	TH	-	-
Introduction to linear programming. The geometry of linear programming. The simplex method. Duality theory. Sensitivity analysis. Network flow problems. Interior point methods. Convex Analysis. Game Theory. Regression. Structural Optimization. The KKT System. The Homogeneous Self-Dual Method. Integer Programming.				

DS5106	Graph Theory	TH	-	-
Fundamentals: Subgraphs, Degrees of Vertices, Paths and Connectedness, Line Graphs. Directed Graphs: Basic Concepts, Tournaments, k-Partite Tournaments. Connectivity: Vertex Cuts and Edges Cuts, Connectivity and Edge Connectivity, Blocks, Cyclical Edge Connectivity of a Graph, Menger's Theorem. Trees: Centres and Centroids, Counting the Number of Spanning Trees, Cayley's Formula, Cayley's Formula. Independent Sets and Matchings, Vertex-Independent Sets and Vertex Coverings, Edge-Independent Sets, Edge-Independent Sets, Matchings and Factors, Matchings in Bipartite Graphs, Perfect Matchings and the Tutte Matrix. Eulerian and Hamiltonian Graphs: Pancyclic Graphs, Hamilton Cycles in Line Graphs, 2-Factorable Graphs. Graph Colorings, Vertex Colorings, Critical Graphs, Homomorphisms and Colorings, Triangle-Free Graphs, Edge Colorings of Graphs. Planarity: Planar and Nonplanar Graphs, Euler Formula, Kuratowski's Theorem, Hamiltonian Plane Graphs. Triangulated Graphs: Perfect Graphs, Triangulated Graphs, Interval Graphs, Circular Arc Graphs.				

DS5107	Image Processing	TH	-	-
Introduction to image processing, Elements of a digital image processing system. Image acquisition, storage, processing, transmission, and display. Image processing fundamentals; human vision system. Sampling and quantization (spatial and brightness resolution). Pixels and their relationships. Digital image processing techniques; image enhancement and restoration, pixel point processing, pixel group processing, frequency domain processing (Fourier transform). Image analysis. Coding systems; error detection and correction. Data compression schemes.				

DS5108	Mobile Computing	TH	-	-
Introduction to Mobile Computing Concepts, Characteristics of Mobile Computing. Cellular Mobile Communication, Evolution of Cellular Communication Technology Cellular Mobile Technologies: GSM, GPRS, UMTS, LTE. Wireless Networking for Cellular Mobile Communication: MAC Protocols, Mobile Internet Protocol, Mobile Transport Layer, Data storage on the device, Record Management System, SMS-Databases and other options, Location based services, Bluetooth integration. Mobile Operating Systems Architecture, Popular Mobile Operating Systems. Mobile Application Development Protocols: Java Clients, Mobile Ecosystem, Networking Java clients, Connectivity with mobile to consume services and send data. Business model development and Mobile Commerce. Social and professional issues of Mobile computing.				

DS5109	Data Science for Bioinformatics	TH	-	-
Introduction to Bioinformatics. Archives and information retrieval (Database search). Sequence alignment (Types, alignment methods, sequence search), multiple sequence alignment. Phylogeny. Gene prediction. Bioinformatics algorithms (Clustering; K-means, Hierarchical). Genomic data analysis. Workflow systems for bioinformatics. Future trends of bioinformatics.				

DS5110	Human Resource Management	TH	-	-
Uniqueness of Human Resource, Human Resource Management, Purpose of HRM, Importance & Responsibility for functions of HRM, Jobs, job designing & Job analysis. The necessity for Job re-designing, Job redesigning methods, Alternative work schedules. Value of Job Analysis, Job Description & Job Specification, HR Planning, HR Planning Process Recruitment & process of recruitment, Employer branding, New trends in recruitment – Active Sourcing/SNS recruitment. Significance of employee selections, Selection methods & selection process, Errors in employee selection Process of hiring, Probationary period, Employee orientation. Definition of Employee Performance Evaluation (EPE), Significance of EPE, EPE methods, Developing PE system. Definition–Learning, Education, training, development, Learning Principles, Training needs analysis. Training programme designing, Effective implementation of training Programmes, Evaluation of training programmes. Reward & total reward, Basic Salary determination - Job evaluation, Pay survey, Performance based pay, Employee benefits, Legal provisions for reward management in Sri Lanka. Grievance Handling (GH), Importance of GH, Methods of GH, Practical tips in HG. Discipline management, Hot Stove Model, Misconducts, Domestic Inquiry. The concepts of occupational health & safety, Hazards & factors				

affecting health & safety, Interventions for improving health & safety. Human Resource Information Systems. Green HRM, HR Analytics, HR Scorecards.

DS5111	Parallel and Distributed Computing	TH	-	-
Introduction to Parallel & Distributed Programming (definitions, taxonomies, trends). Parallel Computing Architectures, Paradigms, Issues, & Technologies (architectures, topologies, organizations). Parallel Programming (performance, programming paradigms, applications). Parallel Programming Using Shared Memory I (basics of shared memory programming, memory coherence, race conditions & deadlock detection, synchronization). Parallel Programming Using Shared Memory II (multithreaded programming, OpenMP, pthreads, Java threads). Parallel Programming using Message Passing - I (basics of message passing techniques, synchronous/asynchronous messaging, partitioning & load-balancing). Parallel Programming using Message Passing - II (MPI), Advanced Topics (accelerators, CUDA, OpenCL, PGAS). Introduction to Distributed Programming (architectures, programming models). Distributed Programming Issues/Algorithms (fundamental issues & concepts - synchronization, mutual exclusion, termination detection, clocks, event ordering, locking). Distributed Computing Tools & Technologies I (CORBA, JavaRMI). Parallel & Distributed Computing – Trends & Visions (Cloud & Grid Computing, P2P Computing, Autonomic Computing).				

Semester VI				
DS6101	Introduction to Deep Learning	TH	PRS	-
Probability and Information Theory for Deep Learning. Deep feedforward networks. Regularization in deep networks. Optimization for training deep models. Convolutional Neural Networks. Practical: Exercises on CNN, solving a problem with CNN on TensorFlow.				

DS6102	Bayesian Learning and Graphical Models	TH	PRS	-
Bayes rule and distributions. MLE and Bayesian learn. Patterns – clustering. Bayes nets. Variable elimination. Inference parameters. Structure Learning. Undirected graphical models.				

SE6103	Mathematical Optimization	TH	-	-
Linear programming (LP): Mathematical formulation of the LP problem, Graphical solution method, Simplex method, Two-phase simplex method, Interior-point method, Duality in LP, Duality theorems, Dual-simplex method. Network Model: Introduction to network models, Transportation Problem, Assignment problem, Shortest path problem. Advanced Linear Programming: Dantzig-wolf decomposition algorithm, Goal programming. Integer programming: Branch-and–bound, Cutting planes. Non-linear programming: Kuhn-Tucker conditions, Dynamic Programming, Quadratic programming. Non-traditional Optimization algorithms: Simulated Annealing (SA), Genetic Algorithm (GA). Modeling Practice: Modeling in the Real World.				

DS6104	Industrial Training	-	-	THS
Students will be required to complete industrial training related to Data Science at				

a relevant industry or research institution. The duration of the project period should be a minimum of 15 weeks. A project report should be submitted at the end of the semester & should be presented & defended by the respective student in front of an evaluation panel appointed by the department.

DS6105	Web Services	TH	PRS	-
Students will be required to complete industrial training related to Data Science at a relevant industry or research institution. The duration of the project period should be a minimum of 15 weeks. A project report should be submitted at the end of the semester & should be presented & defended by the respective student in front of an evaluation panel appointed by the department.				

DS6106	Cloud Computing	TH	PRS	-
Cloud Computing Concepts: Introduction to cloud computing, Properties, characteristics & disadvantages, Gossip, Membership & Grids, P2P Systems, Key-Value Stores, Time & Ordering Classical Distributed Algorithms. Cloud Systems & Infrastructure: Cloud computing stack, Service model, Deployment models, Containers, virtual machines, MAAS, PAAS, Web Services. Storage: Ceph, SWIFT, HDFS, NAAS, SAN, Zookeeper. Big Data & Applications in the Cloud: Spark, Hortonworks, HDFS, CAP, Streaming Systems, Graph Processing & Machine Learning. Cloud Resource management & Service management in cloud computing. Cloud Networking: Introduction to cloud networking SDN with cloud, Data center networking. Cloud security: Identity & Access management, Access control, Authentication in cloud computing. Developing application in cloud platform, Introduction to Cloud Computing with AWS, Azure google's cloud platform. Research trends in cloud: Edge & Fog computing, cloud & IoT. Practical: Hands on experience using a cloud-based tool.				

DS6107	Business Process Management	TH	-	-
Business Processes (basic concepts, modeling). Design, analysis, verification & refinement methods. Workflow Systems (organization & architecture). Synchronization, control, communication & monitoring of process enactment. Workflow Analysis. Workflow Patterns. Workflow development tools & software.				

DS6108	Software Quality Assurance	TH	PRS	-
Introduction to Software Quality and Software Quality Assurance (SQA). The components of the software quality assurance system, Software project life cycle components, Infrastructure components for error prevention and improvement, Management SQA components, SQA standards, system certification, and assessment components. Testing Concepts Definition, Types and Levels of testing, Black vs. White Box testing. Test Techniques, White Box techniques, Black Box techniques, Test Planning. Test Design Specifications, Test Cases, Test Metrics, Pre-process metrics: Estimation, In-process metrics: Process Management, End-process metrics: Process Improvement. Test Management, Test planning, resource management, test reporting, tools. Test Automation: Web test automation, Mobile test automation, Test script writing. SQA Standards, certification and assessment. Organizing for quality assurance, Management and its role in software quality				

assurance. Practical: Hands on experience with a SQA Tool for authoring functional tests.

DS6109	Fraud and Anomaly Detection	TH	PRS	-
An Introduction to anomalies. Probabilistic and Statistical models for anomaly detection. Linear models for anomaly detection. Supervised anomaly detection. Deep learning-based anomaly detection. Anomaly detection in categorical and high-dimensional data. Mining anomalies in graph data. Time series and multidimensional streaming anomaly detection.				

Semester VII				
DS7101	Research Method	TH	-	-
Introduction to the notion of research. Literature review. Research designs. Identifying data requirements, sources, & instruments for data gathering. Undertaking 'experiments'. Validation: Types of validation. Analysing research data. Writing Strategies. Ethical Consideration.				

DS7102	Advanced Deep Learning	TH	PRS	-
Recurrent and recursive deep networks. Linear factor models. Generative Deep Learning: Auto encoders, Variational encoders, Generative adversarial networks, Neural transfer. Representation Learning. Deep Learning Research and their applications. Practical: Exercises on RNNs, solving a problem with RNNs on TensorFlow.				

DS7103	Emerging Trends in Data Science	-	-	PR
Systematic literature review will be conducted by the student independently.				

DS7104	Numerical Methods	TH	-	-
Solving Nonlinear Equations. Linear Interpolation Methods. Solving Sets of Equations. Interpolation and Curve Fitting. Approximation of Functions. Chebyshev Polynomials and Chebyshev Series. Rational Function Approximation. Numerical Differentiation and integration. Numerical Solution of Ordinary. Differential Equations. Optimization. Partial-Differential Equations. Finite Element Analysis.				

DS7105	Natural Language Processing	TH	-	-
NLTK, Python 3 and the Jupyter Notebook, Introduction to HPC. Textual Sources and Formats, APIs, Social Media, Web Scraping. Tokenization, N-grams and Scriptio continua, Stemming and Lemmatization, Synsets and Hypernym. POS Tagging and Stopwords. Text "Features" and TF-IDF Classification. Named Entity Recognition (NER). Sentiment Analysis. Topic Modeling Basics, Topic Modeling; Strengths, Weaknesses, Correlations. Document Clustering and Word Vectors, Doc2vec, Word2vec, Advanced Vector Analysis. Dependency Parsing & Constituency Parsing.				

DS7106	Entrepreneurship and Innovation	TH	-	-
Role of entrepreneurs in national development. Training of entrepreneurs. Essential characteristics of techno-entrepreneurs. Business proposal & assessing criteria.				

Making business proposals. Technology & innovation: Invention, Commercialization & Diffusion, Technology push & market pull. Business models for innovation.				

DS7107	Internet of Things	TH	-	-
Introduction to IoT (Sensing, Actuation, Basics of Networking). Sensor Networks: Machine-to-Machine Communications.: Interoperability in IoT. Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino. Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. SDN for IoT. Data Handling and Analytics. Connected Vehicles, Smart Grid, Industrial IoT. Industrial IoT Case Study: Agriculture, Healthcare, Activity Monitoring, Smart cities, Smart homes.				

DS7108	Design Patterns and Anti-Patterns	TH	PRS	-
Introduction to Design Patterns: A Brief History, How Design Patterns Solve Design Problems, How to Select & Use a Design Pattern. The Catalog of GoF (Gang-of-Four) Design Patterns. Creational Patterns: Abstract Factory, Factory Method, Singleton. Structural Patterns: Adapter, Composite, Decorator. Behavioral Patterns: Observer, Strategy, Template Method Pattern. Model-View-Controller (MVC) Pattern. Design Principles for creating software that is flexible, reusable, and maintainable. Symptoms of bad design (anti-patterns). Practical: Hands on experience in modeling using a UML professional design software and OOP programming.				

DS7109	Ontology Engineering	TH	PRS	-
Introduction to Knowledge Representation and the Semantic Web. Introduction to the Web Ontology Language OWL. Description logics and classifiers. Description Logics Syntax, Semantics, and reasoning problems. Methods for developing and evaluating ontologies. Common problems and patterns in ontology development. Application development using the OWL API. Practical: Introduction to Protege and OWL including advanced tutorial, Special problems of representation and reasoning in OWL, Practical individual development project using Java, Critique/comment on implemented ontologies on the Web.				

DS7110	Blockchain and Cryptocurrency	TH	-	-
Intro to cryptography & cryptocurrencies. Technological and Cryptographic Elements in Blockchain, Blockchain Platforms. Consensus: network models, corruption tolerance. Ethereum: Decentralized Apps, EVM, and the Ethereum blockchain. Decentralized finance and economics. The Limitations, Opportunities and Challenges of Blockchain. Privacy on a public blockchain, Legal Regulations for Blockchain.				

Semester VIII				
DS8101	Research Project in Data Science	-	-	THS
The course starts with a reflection and discussion about interdisciplinary research, where students define their research topics. Throughout the course, the students				

work in developing their research questions and choose the appropriate methodological approaches for their research and analyze the results. Students should be able to provide valid findings in selected research domains and report in a format of thesis and submit it to the department. They are encouraged to present their findings in local and international research forums.

DS8102	Information Retrieval and Web Analytics	TH	-	-
Introduction to IR. Basic IR Models. Basic Tokenizing, Indexing, and Implementation of Vector-Space Retrieval. Performance metrics: recall, precision, and F-measure; Evaluations on benchmark text collections. Relevance feedback; Query expansion; Query languages. Text Representation and clustering. Recommender Systems. Ethical Issues in IR. Web search. Introduction to Web Analytics. Basic Segmentation, Intermediate Metrics, Custom Metrics, Calculated Metrics. How to use Adobe Analytics, IBM Core metrics and Google Analytics.				

DS8103	Reinforcement Learning	TH	-	-
Introduction. Bandit problems and online learning. Markov decision processes. Returns, and value functions. Dynamic programming. Monte Carlo learning. Temporal difference learning. Eligibility traces. Value function approximation (function approximation). Models and planning (table lookup case).				

DS8104	Computational Intelligence	TH	-	-
Introduction to Computational Intelligence (Important literatures on the topic of artificial neural networks (ANN), general concept of ANN, different types of ANN, different types of learning (supervised and unsupervised learning), and applications of ANN algorithms in real world). Genetic Algorithms (General concept and features of GAs, different types of GAs, different strategies of using GA features, and applications of GA algorithms in real world). Swarm Optimization (General concept and features of swarm optimization, different types of swarm optimization algorithms and their concepts/features, and applications of swarm optimization algorithms in real world). Fuzzy Systems (Important literatures on the topic of fuzzy systems, general concept and features of fuzzy systems, different strategies for using features of fuzzy systems, and applications of fuzzy systems in real world). Hybridization of CI Algorithms (Important literatures on the topic of hybridization of computational intelligence algorithms, why such hybrid algorithms can be beneficial, the general concepts of how to combine algorithms, different types of hybrid algorithms and their benefits, and applications of such hybrid algorithms in real world).				

DS8105	Business Analytics and Applications	TH	-	-
Introduction to business analytics. Finance Analytics. Marketing Analytics. Supply Chain Analytics. Human Resources Analytics. Customer Relationship Management Analytics. Manufacturing Industry Analytics.				

DS8106	Geographical Information Systems	TH	PRS	-
Introduction to GIS - What is Geographic Information Systems, Different components of GIS, Different types of vector data, Raster data models & their types, TIN data model. Data Representations - Advantages & disadvantages associated				

with vector, raster & TIN, Non-spatial data (attributes) & their type, Raster data compression techniques, Different raster data file formats, Spatial database systems & their types. Map Projections - Pre-processing of spatial datasets, Different map projections, Spatial interpolation techniques, Different types of resolutions, Digital Elevation Model (DEM). Geographic Phenomena. Practical: Hands on experience with GIS, Hands on experience with different spatial related APIs (Geo Coding API, LocationIQ API, Google Maps API etc.).

DS8107	Digital Forensics	TH	-	-
Basic principles and methodologies for digital forensics, Design systems with forensic needs in mind. Rules of Evidence – general concepts and differences between jurisdictions and chain of custody, Search and seizure of evidence: legal and procedural requirements. Techniques and standards for preservation of data. Legal and reporting issues including working as an expert witness, OS/File system forensics - Windows, mac, android etc. Application, Web, Network and Mobile forensics - Network forensics: provides the tools to collect information regarding network traffic. Attack detection and investigation. Methods to detect and investigate cyber-attacks, Anti-forensics. Any tools or software that is used to disrupt a computer investigation.				

DS8108	Business Process Simulation	TH	-	-
Simulation in management decision making. Queuing theory. Concepts of discrete-event simulation. Construction of models: Modeling issues, Verification & Validation of models. Practical: Use of computer simulation tools.				

DS8109	Robotics	TH	PRS	-
Fundamentals of Robotics. Modern robotics: manipulator robots. Mechanics of manipulator robots: position and orientation. Direct and inverse kinematics, static forces and speeds. Singularities, dynamics. Matlab modeling of a manipulator's kinematics and dynamics. Manipulator robots' control: trajectories. Digital control: Synthesis, Syntony and analysis of PID controllers. Structures and sensors. Manipulator robots' programming: languages. Off-line and on-line programming; remote access: Monitoring and Supervision. Fundamentals of Bionics. Human-machine interface systems. Practical: Applications in clean/laboratorial environments, automated guided vehicles.				