



INDIAN INSTITUTE OF INFORMATION TECHNOLOGY
LUCKNOW

M.SC IN DATA SCIENCE



**DEPARTMENT
OF
MATHEMATICS**

AT A GLANCE

IIIT Lucknow is among 20 IIITs established under the Government's Public-Private-Partnership (PPP) model, striving to become a premier center of excellence in Information Technology. With state-of-the-art academic and non-academic facilities, it aims to nurture talent and strengthen India's technological edge.

The M.Sc. in Data Science program in IIIT Lucknow is crafted to foster data storytelling skills and make students industry-ready.

Designed for individuals with a basic background in Mathematics, Statistics or Computer Science which ensures accessible learning. The curriculum emphasizes hands-on experience, offering capstone projects after each semester to bridge theory and real-world applications.

CONTACT



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<https://iiitl.ac.in>

ELIGIBILITY AND SELECTION

JAM
JOINT
ADMISSION
TEST FOR
MASTERS

Bachelor's degree (B.A. /B.Sc. /B.Stat./ B.Math./B.Tech/B.E. or equivalent) with a background in Mathematics, Statistics, Computer Science or Physics. Those in the final year of their undergraduate program are also eligible to apply. Selection for the programme will be through Joint Admission Test for Masters (JAM). Students should have working knowledge of coding in any one programming language and atleast one subject of Computer programming Language C/C++/Java/Python should have been passed with minimum 60% marks or completed a certificate course in any of the programming languages.

HOW TO APPLY

CCMN (CENTRALIZED COUNSELLING FOR M.SC. ADMISSION) is a common platform for candidates to apply for M.Sc. programmes, based on their JAM score, in IITs, NITs and some GFTIs (for details, please refer to the list of participating Institutes on the CCMN website). This centralized system provides a common and convenient platform for online counselling wherein the candidates can fill in a single online application from their homes and apply to all programmes in all the participating institutions to which they are eligible.

CCMN



[HTTPS://CCMN.ADMISSIONS.NIC.IN/](https://ccmn.admissions.nic.in/)

SEAT MATRIX

OPEN	OPEN PWD	EWS	EWS PWD	ST	SC	OBC NCL	TOTAL
11	1	3	0	5	2	8	30

FEE STRUCTURE

SEM	I	II	III	IV
TOTAL FEES	72000	51500	53500	51500

* HOSTEL AND MESS CHARGES WILL BE SEPARATE

NEP 2020

Multiple Entry Multiple Exit

According to 11.5 of NEP 2020 (pp 37), we have implemented multiple entry and exit point for our M.Sc. 2023 batch onwards in the following manner:

Any student can leave the course after FIRST Year of M.Sc.; such students will be granted Post Graduate Diploma in Data Science.

Cooling Period

The student who wants to leave his/her study after FIRST year can leave, however to complete the M.Sc. Degree, (s)he has to come back and join the course directly in SECOND year within the BLOCK period of two years. (S)He will get at most four years to complete M.Sc. degree.

Multidisciplinary Education

According to 11.7 of NEP 2020 (pp 37), A course in Professional Communication and Sports have been included in the course structure.

Multi-Mode and Digital Education

According to The Point 24 of NEP 2020 (pp 58), The subjects which are running in online mode, will be evaluated through proctored online examination.

COURSE STRUCTURE FOR M.SC. DATA SCIENCE

I

First Semester

- Computational Thinking through Programming (4 credits)
- AI & ML with Python (4 credits)
- Mathematical Methods for Data Science and AIML (4 credits)
- Introduction to Probability and Statistics (4 credits)
- Professional Communication (3 credits)
- Yoga & Fitness (1 credits)

Second Semester

- Big Data Analysis (4 credits)
- Deep Learning (4 credits)
- Data Structures and Algorithms with Python (4 credits)
- Applied Statistics (4 credits)
- DBMS (4 credits)

II

Third Semester

- Data Mining and Warehousing (4 credits)
- Reinforcement Learning (4 credits)
- Elective-I (4 credits)
- Elective-II (4 credits)
- Data Science Capstone Project I: Project Preparation (4 credits)

III

Fourth Semester

- Data Science Capstone Project II: Project Implementation (20 credits)

IV

POOL OF ELECTIVES

- Natural Language Processing (NLP)
- Optimization Technique
- Stochastic Process
- Quantum Communication
- Business Analytics
- Cloud Computing
- Bayesian Data Analysis
- Soft Computing

CLIMATE DATA ANALYTICS

Data science students can explore a specialization in Climate Data Analytics, a field that harnesses advanced data techniques to address environmental challenges. This specialized track equips them with the skills to analyze large-scale climate datasets, develop predictive models, and gain insights into patterns such as weather trends, carbon emissions, and climate change impacts.

In addition to gaining theoretical knowledge, students pursuing this path will have the exciting opportunity to intern at Climate Resilience Observatory (CRO). These internships offer hands-on experience with real-world data, allowing students to contribute to meaningful projects focused on sustainability, environmental forecasting, and policy-making.

Through this exposure, they will work alongside experts, refine their technical competencies, and enhance their problem-solving abilities—preparing them to make impactful contributions in the growing field of climate science.

COURSE STRUCTURE FOR M.SC. DATA SCIENCE (SPECIALIZED IN CLIMATE DATA ANALYTICS)

I

First Semester

- Computational Thinking through Programming (4 credits)
- AI & ML with Python (4 credits)
- Mathematical Methods for Data Science and AIML (4 credits)
- Introduction to Probability and Statistics (4 credits)
- Professional Communication (3 credits)
- Yoga & Fitness (1 credits)

Second Semester

- Big Data Analysis (4 credits)
- Deep Learning (4 credits)
- Data Structures and Algorithms with Python (4 credits)
- Applied Statistics (4 credits)
- DBMS (4 credits)

II

III

Third Semester

- Global Warming: The Science and Modeling of Climate Change (4 Credits)
- Blockchain: Crypto Assets and Tokens (4 Credits)
- Climate change and Human Rights (4 Credits)
- Climate Risk, Value and Investing (4 Credits)
- Innovation and Design Thinking (4 Credits)

Fourth Semester

- Thesis/Industry Project (20 credits)

IV

COURSE CONTENT

FIRST SEMESTER

COMPUTATIONAL THINKING THROUGH PROGRAMMING

Introduction to Digital Computer and Programming: Basic components of computer, binary representation, bits and bytes, program, software.

Introduction to Computational Thinking: Procedural computational approach to real life problems, idea of algorithms, creating flowcharts and pseudo-code.

Introduction to Computational Problem Solving through C: Programming language concepts and its applicability on problem solving, introducing C programming language, inputs and outputs, compiling and running C program

C Fundamentals: C character set, identifiers and keywords, data type, constants, declarations, operators (arithmetic, relational, logical, assignment, unary, bitwise, etc.).

Control Statements: Branching: if-else, Looping: while, do-while, for, nested control, switch, break, continue, goto.

Functions: Defining a function, accessing a function, function prototypes, argument passing, recursion.

Variables: variable and their scopes, automatic, external/global, static variables.

Arrays: Defining an array, processing arrays, passing arrays to functions, multi-dimensional arrays.

Structure and Unions: Defining and processing a structure, user defined data types, structures and pointers, passing structure to functions, self-referential structures, Unions.

Data Files: File handling, multi-file programming.

String: Defining and processing string. Various operations on string.

Program analysis: Debugging programs with gdb, memory analysis using valgrind.

AI AND ML WITH PYTHON

Introduction to AI: This unit lays the groundwork by introducing the basic principles and applications of AI. Topics include an overview of AI, the differences between weak and strong AI, the historical milestones in the AI field, the Turing Test and its implications, and an interdisciplinary approach to Cognitive Science and AI.

Agents and Problem Solving: This unit delves into agents and their types, focusing on rational agents and types like reactive and cognitive agents. The methodologies and approaches to AI like symbolic, sub-symbolic, and hybrid approaches are also discussed. The unit also introduces expert systems, their components, applications, and limitations. Problem-solving techniques using search algorithms like Breadth-First Search are initiated along with Game Playing and Game Theory.

Logic and Data Pre-processing: In this unit, students will continue exploring problem-solving by search algorithms, focusing on Depth-First Search and A* algorithms. The unit will then move into Predicate Logic, covering syntax, semantics, quantifiers, and inference. Data pre-processing techniques for handling missing values, outliers, and transformations will also be discussed.

Basics of Machine Learning: This unit provides an introduction to the field of Machine Learning. It covers the fundamentals, including the types of machine learning like supervised and unsupervised learning, as well as data normalization techniques such as Min-Max scaling and Z-score normalization.

Advanced Machine Learning Algorithms: In this more advanced unit, various machine learning algorithms are discussed in detail. This includes unsupervised learning models like clustering and association. Linear Regression is covered in two parts: theory and Python implementation.

Capstone Project: A capstone project using majority of the above modules.

MATHEMATICAL METHODS FOR DATA SCIENCE & AI ML

Vectors and Matrices: Vectors in data science, machine learning and artificial intelligence, Basics of Matrix Algebra, Vector Space, Subspace, Basis and Dimension. Linear Transformations, Norms and Spaces, Orthogonal Complement and Projection Mapping, Eigenvalues and Eigenvectors, Special Matrices and Properties.

Matrix Decomposition and Its Applications: Spectral Decomposition, Singular Value Decomposition, Low Rank Approximations, Principal Component Analysis, Linear Discriminant Analysis, Applications of Low-rank Approximation, SVD, PCA, LDA.

Calculus and Least Square Approximation: Basics concepts of Calculus, gradient, Jacobian, Chain rule, Change of variables. Least Square Approximation and Minimum Norm Solution, Linear and Multiple Regression, Logistic Regression. Classification Metrics, Gram Schmidt Process, Polar Decomposition, Minimal Polynomial and Jordan Canonical Form, Some more Matrices, Applications of these concepts in Data Science, Machine Learning and Artificial Intelligence.

Optimization: Convex sets and convex functions, properties of convex functions, Introduction to Optimization, Numerical Optimization in Machine Learning, Gradient Descent and other optimization algorithms in machine learning, Introduction to SVM, Error minimizing LPP, Lagrangian Multiplier method, concepts of duality, hard and soft margin classifier, Applications of Optimization, SVM.

INTRODUCTION TO PROBABILITY AND STATISTICS

Probability: Combinatorial probability, Independence of events, Conditional probabilities

Random variables: Random variables, densities, Expectation, Variance and moments, Standard univariate distributions, Independence of random variables, Moment Generating Functions

Law of Large Numbers: Tchebychev's inequality and weak law of large numbers, Central Limit Theorem.

Probability Distributions: Marginal Distribution, Conditional Distribution, Conditional expectation, Correlation, Bivariate normal distribution, Multivariate normal distribution

Function of random variables: Linear Combinations, Expectation of function of random variables, Moment Generating Functions

Important distributions: Binomial, Geometric, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Weibull, Normal.

Sampling: Random sampling methods, Bias and Variance, Bootstrap methods.

Estimation: Point and interval estimation, Maximum Likelihood Estimation (MLE), Bayesian Estimation, Properties of Estimators.

PROFESSIONAL COMMUNICATION

Basics of Communication: Overview of Communication, Types of Communication, 7 Cs of Communication, Barriers to Communication, Need for Professional Communication, Role of Professional Communication in Industries, Job Opportunities in Professional Communication

Conversation: Creating a Communication Strategy, Introducing Yourself, Networking, Conversation and Dialogues: Starting a Conversation, Ending a Conversation, Telephonic Conversation, How to Handle Difficult Conversations, What to Say and What Not to Say in Crisis Situation

Non-Verbal communication: Body Language: Facial Expressions, Posture, Eye Contact, Kinesics, Proxemics, Chronemics, Haptics, Cross-Cultural Communication, Voice Features: Tone, Voice Modulation, Fluency, Rate of Speech, Pitch

Effective Speaking: How to Cope with Public Speaking Anxiety, Presentation Skills: Planning, Composition, Review, Oral Presentation, Online Presentation, Interview, Group Communication Introducing Others, Giving Feedback, Delivering Bad News, Group Discussions.

Communicating with People in Stress: Awareness about Psychological Impact of Stress, What People Experience in a High-Stress Environment, Positive Communication: Practicing Empathy, A Good Listener, Reassurance, Follow Up.

SECOND SEMESTER

DBMS

Introduction to Databases and DBMS: Overview, Database System vs File System, Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and Database Language and Interfaces, Data Definitions Language, DML, Overall Database Structure, Data Modeling Using the Entity Relationship Model: ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Keys, Concepts of Super Key, Candidate Key, Primary Key, Generalization, Aggregation, Reduction of an ER Diagrams to Tables, Extended ER Model, Relationship of Higher Degree.

Relational Model: Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple and Domain Calculus, Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQL Data Type and Literals, Types of SQL Commands, SQL Operators and Their Procedure, Tables, Views and Indexes, Queries and SubQueries, Aggregate Functions, Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL.

Database Design and Normalization: Functional dependencies, Normal forms, First, Second, Third Normal Forms, BCNF, Inclusion Dependence, Loss less Join Decompositions, Normalization using FD, and MVD.

Transaction Management and Concurrency Control: Concept of Transaction System, States of Transaction and Its Properties, Testing of Serializability, Serializability of Schedules, Conflict & View Serializable Schedule, Concurrency Control, Locking Techniques for Concurrency Control, Time Stamping Protocols for Concurrency Control.

Recovery Management: Need of Recovery management, Recoverability, Recovery from Transaction Failures, Log Based Recovery, Checkpoints, Deadlock Handling.

BIG DATA ANALYSIS

Introduction to Big Data Processing: Introduction to Big Data Analytics. What is Big Data? What are the challenges? Introduction to Apache Hadoop and MapReduce. History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System

HDFS:Hadoop Distributed File System: HDFS(Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Map Reduce: Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features

Hadoop Eco System: Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL : Introduction

Machine Learning Algorithms for Big Data Analytics: Introduction, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Frequent Itemsets and Association Rule Mining. Text, Web Content, Link, and Social Network Analytics: Introduction, Text mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and analyzing a Web Graph, Social Network as Graphs and Social Network Analytics

DEEP LEARNING

Deep Neural Network: Introduction to Deep Learning: A brief overview of supervised, unsupervised, reinforcement learning, Difference between classification, regression, Traditional classifiers, Multilayer Perceptron: Feed-Forward Neural Network with Backpropagation, Different activation functions their advantages and disadvantages: Sigmoid (vanishing gradient problem), ReLU (exploding gradient problem), Leaky ReLU, tanh, etc., Various loss and cost functions: MSE, log-loss, cross-entropy, hinge loss, etc., Bias vs Variance trade-off, Regularization: L2 regularization, early stopping, data augmentation, Ensembling, Dropout, etc., Optimization: Gradient Descent (GD), Batch GD, Stochastic GD, Minibatch GD, GD with momentum, Adagrad, RMSprop, Adam, etc.

Convolutional Neural Network: Introduction to Convolution Neural Network (CNN), Different operations of CNN (convolution, pooling), Different concepts of CNN (Kernel, Filter, Padding, Stride), Different CNN architecture (LeNet, AlexNet, VGG Net, GoogLeNet, SqueezeNet, Xception net, Residual block and ResNet, Dense Net, etc.), Transfer Learning, Similarity learning, Siamese Net, Triplet Net

Advanced Topics on Deep Learning: Autoencoder: Denoising autoencoder, Sparse autoencoder, Variational autoencoders, etc., Generative Adversarial Network (GAN) and some of its variants, e.g., DCGAN, CycleGAN

Applications of Deep Learning: Application of Deep Learning (DL) in Computer Vision: Object Segmentation: U-Net, V-Net, Object Detection: RCNN, YOLO, etc., Application of DL in Natural Language Processing (NLP): e.g., Sentiment Analysis from reviews

APPLIED STATISTICS

Regression Analysis: Simple and Multiple Linear Regression, Assumptions, Residual Analysis, Implementation in Python.

Hypothesis Testing: Parametric and Non-Parametric Tests, t-tests, Chi-Square Test, p-values, Type I & II Errors.

Design of Experiments: One-way and Two-way ANOVA, F-test, Implementation in Python.

Poisson process, Markov Chains: Transition Probabilities, Stationary Distributions, Applications in Statistics.

DATA STRUCTURES AND ALGORITHMS IN PYTHON

Introduction to Data Structures and Algorithms: Overview of DSA and its importance in problem-solving, Time and Space Complexity Analysis, Asymptotic Notations (O , Ω , Θ notations), order of growth. Basic sorting, searching algorithms.

Fundamental Data Structures:

1. Introduction to Array, Array representation, Contiguous storage. Definition, operations, advantages, and limitations Divide and conquer Technique- Implementing Arrays in applications e.g., MergeSort, Quicksort, Binary Search. Recurrences and their solution- Master's theorem, Iteration, Recursion Tree.
2. Stacks, operations , Applications- expression evaluation Infix, postfix, prefix, towers of Hanoi
3. Queue operations-Circular, Double ended, Priority
4. Dynamic Programming and analysis: Memoization using 2-D arrays, 0/1 KSP, LCS, MCM

Advanced Data Structures: Trees: Binary Trees, Binary Search Trees (BST), AVL Trees, Heaps: Min-Heap and Max-Heap, Priority Queues, Graphs: Representation (Adjacency Matrix & List), BFS and DFS traversal, Shortest Path Algorithms (Dijkstra, FloydWarshall) Backtracking and analysis: N-Queens Problem, Branch and Bound : TSP, 0/1 KSP Greedy Algorithms and analysis: Coin Selection, MCST Algorithms, F-KSP, TSP, Shortest path algorithm

Computational complexity: P, NP, NP-C, NP-H classes and example problems-SAT, Clique problem

THIRD SEMESTER

.For MSc Data Science.

DATA MINING AND WAREHOUSING

Part I: Overview: Motivation (for Data Mining), Data Mining Definition and Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data, (Binning, Clustering, Regression, Computer and Human inspection), Inconsistent Data, Data Integration and Transformation. Data Reduction: Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation.

Part II: Concept Description: Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases. Association rule mining: mining Single-Dimensional Boolean Association rules from Transactional Databases, Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multi-Dimensional Association rules from Relational Databases.

Part III: Classification and Predictions: What is Classification and Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multi-layer feed-forward Neural Network, Back propagation Algorithm, classification methods K-nearest neighbour classifiers, Genetic Algorithm. Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, partitioning methods. Hierarchical Clustering- CURE and Chameleon. Density Based methods DBSCAN, OPTICS. Grid Based Methods- STING, CLIQUE. Model Based Method Statistical Approach, Neural Network approach, Outlier Analysis.

Part IV: Data Warehousing: Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi Dimensional Data Model, Data Cubes, Stars, Snow flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture

Part V: Data Marting. Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse.

REINFORCEMENT LEARNING

- Multi-armed bandits
- Finite Markov Decision Processes
- Optimal policies and value functions
- Dynamic Programming. Policy evaluation. Policy improvement. Policy iteration.
- Monte-Carlo Methods.
- Temporal-Difference Learning.
- N-step Bootstrapping.
- Planning and learning with tabular methods
- Overview of Approximate solution methods.

INTRODUCTION OF DATA SCIENCE CAPSTONE 1 – PROJECT PREPARATION

This course is part one of a two-course capstone sequence where students organize, select project topics, write a project, proposal and begin preparing project data sets.

THIRD SEMESTER

.For MSc Data Science.
(Climate Data Analytics)

GLOBAL WARMING: THE SCIENCE AND MODELLING OF CLIMATE CHANGE

Module 1: Introduction to Climate Science, Basics of Climate Systems, Overview of Earth's climate system, Greenhouse gases and their impact, Historical Climate Changes, Ice ages and interglacial periods, Paleoclimatology methods.

Module 2: Understanding Global Warming, The Greenhouse Effect, Mechanisms and contributing factors, Implications for global temperatures, Evidence and Indicators, Temperature records and trends, rising sea levels and melting ice.

Module 3: Climate Modelling, Fundamentals of Climate Models, Types of climate models, Key components and variables, Creating and Testing Models, Data collection and input, Model validation and accuracy.

Module 4: Impacts of Climate Change, Ecological Impacts, Effects on biodiversity and ecosystems, Species migration and extinction risks, Socioeconomic Impacts, Impact on agriculture and food security, Health and social inequality.

Module 5: Mitigation and Adaptation, Mitigation Strategies, Renewable energy sources, Policies and international agreements, Adaptation Techniques, Resilient infrastructure, Community, and ecosystem-based adaptation.

BLOCKCHAIN: CRYPTO ASSETS AND TOKENS

Module 1: Introduction to Blockchain Technology: Fundamentals of Blockchain, Concept and History, Key Components: Blocks, Chains, and Nodes, Blockchain in Context . Types of Blockchains: Public, Private, Hybrid. Real-world Applications

Module 2: Crypto Assets and Tokens, Understanding Cryptocurrencies, Bitcoin: The Pioneer, Altcoins and their Uses, Tokens and Tokenization, Types of Tokens: Utility, Security, and Governance Tokens, Tokenization of Assets, and its Implications.

Module 3: Blockchain and Climate Data Analytics, Blockchain in Environmental Sustainability, Tracking Carbon Emissions, Renewable Energy Certificates, Climate Data on the Blockchain, Secure Data Sharing, Improving Transparency and Accountability

Module 4: Regulatory and Ethical Considerations: Legal Frameworks, Regulatory Approaches to Cryptocurrencies and Tokens, Compliance and Security Standards, Ethical Issues, Privacy and Security Concerns, Ethical Implications of Blockchain Technology,

Module 5: Practical Applications and Future Trends: Case Studies- Successful Implementation of Blockchain in Various Industries, Lessons Learned and Best Practices, Future Trends and Innovations, Emerging Technologies and Their Impact, The Future of Blockchain in Climate Data Analytics.

CLIMATE CHANGE AND HUMAN RIGHTS

Module 1: Introduction to Climate Change and Human Rights: Overview of Climate Change, Climate science basics, Historical climate changes and projections, Human Rights Fundamentals. Introduction to human rights: Key human rights treaties and frameworks

Module 2: Impacts of Climate Change on Human Rights, Social and Economic Impacts, Effects on vulnerable populations, Climate change and poverty, Environmental Migration and Displacement, Climate refugees, Legal and ethical considerations

Module 3: Legal Frameworks and Policies, International and National Policies, Paris Agreement and other global initiatives, National climate policies and human rights, Legal Rights and Climate Justice, Case studies of climate litigation, Role of courts in protecting human rights

Module 4: Data Analytics and Climate Change, Climate Data Analysis, Tools and techniques for analyzing climate data, interpreting climate data to understand human impacts, Human Rights Data Integration, Combining human rights data with climate data, Predictive analytics for identifying at-risk populations

Module 5: Strategies for Mitigation and Adaptation, Mitigation Strategies, Reducing greenhouse gas emissions, Policy recommendations, Adaptation Techniques, Building resilient communities, Human rights-based approach to adaptation

CLIMATE RISK, VALUE, AND INVESTING

Module 1: Introduction to Climate Risk and Value Assessment: Fundamentals of Climate Risk, Defining climate risk and its dimensions, Historical context and current trends, Valuing Climate Risk, Financial implications of climate risks, Methods of climate risk assessment.

Module 2: Climate Data Analytics for Investment Decisions, Climate Data Sources, Identifying and utilizing relevant climate data, Data quality and reliability, Analyzing Climate Data, Tools and techniques for climate data analysis, Case studies on climate data-driven investment decisions,

Module 3: Sustainable Investing and ESG Criteria: Introduction to ESG Investing, Environmental, Social, and Governance (ESG) criteria, Importance of ESG in investment strategies, Integrating ESG into Investment Portfolios, Methods of evaluating ESG performance, Examples of ESG-driven investment success

Module 4: Risk Management and Climate Resilience, Strategies for Managing Climate Risk, Mitigation and adaptation approaches , Role of insurance and financial instruments, Building Climate Resilience, Enhancing resilience in investment portfolios, Case studies on resilient investments

Module 5: Future Trends and Innovations in Climate Finance, Emerging Trends in Climate Finance, Innovations in financial products and services, Impact of technology on climate risk assessment, Policy and Regulatory Developments, Global and local policy impacts on climate finance, Navigating regulatory frameworks.

INNOVATION AND DESIGN THINKING

Module 1: Introduction to Innovation and Design Thinking: Fundamentals of Innovation, Definition and types of innovation, Historical perspective and case studies, Introduction to Design Thinking, Principles and phases of design thinking, Role in problem-solving and innovation.

Module 2: Empathy and Problem Definition, Understanding Users and Stakeholders, Empathy mapping and user personas, identifying user needs and pain points, Defining the Problem, Techniques for problem definition, Framing and reframing problems for innovation.

Module 3: Ideation and Prototyping, Brainstorming and Ideation Techniques, Creative thinking methods, Collaborative ideation sessions, Prototyping and Experimentation, Building low-fidelity prototypes, Testing and iterating on ideas

Module 4: Implementation and Evaluation, Developing Innovative Solutions, Strategies for implementing solutions, Project management in innovation, Evaluating and Scaling Solutions, Metrics and methods for evaluation, Scaling successful innovations.

Module 5: Innovation in Climate Data Analytics: Applying Innovation in Climate Data, Case studies of innovative climate solutions, Integrating design thinking in climate projects , Future Trends in Innovation, Emerging technologies and their impact, Preparing for future challenges and opportunities

FOURTH SEMESTER

.For MSc Data Science.

DATA SCIENCE CAPSTONE II – PROJECT IMPLEMENTATION

This will ensure a continuity for the workflow of the capstone project preparation which the students start in Semester III. Here students synthesize and apply knowledge and techniques acquired throughout the Master of Science in Data Science program for working with large data sets, deriving insights from data and sharing insights with other people.

FOURTH SEMESTER

.For MSc Data Science.
(Climate Data Analytics)

THESIS PAPER / INDUSTRY PROJECT

Thesis Paper: Students will select a research topic in a specialized area of mathematics or data science. The research will involve problem formulation, literature review, methodology design, data collection and analysis, and finally the formulation of findings and conclusions.

Industry Project: Students will collaborate with industry professionals to solve real-world problems. The project will involve working on industry-specific challenges, applying mathematical models and techniques, collecting and analyzing data, and providing solutions that can be implemented in an industrial context.

Structure: The course is divided into a self-paced research or project phase with consistent guidance from a faculty supervisor or industry mentor. The student will regularly report progress through presentations or written updates.