Name of the Programme : **M.Sc. in Data Science**
Course Code : **CSD-511**
Title of the Course : **MLOps (Theory)**
Number of Credits : **2(2L-0T-0P)**
Contact hours : **30 hours (30L-0T-0P)**
Effective from AY : **2023-24**

Pre-requisites for the course	Familiarity with linear algebra, probability theory, machine learning , familiarity with python.
Course Objectives	This course is aimed at anyone who wishes to 1. Explore deep learning from scratch. 2. This course offers a practical hand on exploration of deep learning, avoiding mathematical notation, preferring instead to explain quantitative concepts through programming using python API

Content	**Unit I:** Introduction to MLOps Rise of the Machine Learning Engineer and MLOps-What Is MLOps?-DevOps and MLOps-An MLOps Hierarchy of Needs-Implementing DevOps-Configuring-Continuous Integration with GitHub Actions-DataOps and Data Engineering-Platform Automation-MLOps MLOps Foundations-Bash and the Linux Command Line-Cloud Shell Development Environments-Bash Shell and Commands-List Files Run Commands Files and Navigation-Input/output-Configuration-Writing a Script-Cloud Computing Foundations and Building BlocksGetting Started with Cloud Computing- minimalistic python revision-Descriptive Statistics and Normal DistributionsOptimization-Machine Learning Key Concepts-Doing Data ScienceBuild an MLOps Pipeline from Zero	**15 hours**

	MLOps for Containers and Edge Devices Containers-Container Runtime-Creating a Container Running a Container-Best PracticesServing a Trained Model Over HTTP-Edge Devices-Coral Azure Percept-TFHub-Porting Over Non-TPU Models-Containers for Managed ML Systems-Containers in Monetizing MLOps-Build Once, Run Many MLOps Workflow Continuous Delivery for Machine Learning Models-Packaging for ML Models-Infrastructure as Code for Continuous Delivery of ML Models-Using Cloud Pipelines-Controlled Rollout of Models-Testing Techniques for Model Deployment AutoML and Kaizen ML-Auto ML-MLOps Industrial RevolutionKaizen Versus Kaizen ML-Feature Stores-Apple's Ecosystem-Apple's AutoML: Create ML-Apple's Core ML Tools or Google's AutoML and Edge Computer Vision or Azure's AutoML or AWS AutoML-Open
	Source AutoML Solutions-Ludwig-FLAML-Model Explainability

	Unit II: Monitoring and Logging-Observability for Cloud MLOps-Introduction to Logging-Logging in Python-Modifying log Levels-Logging Different Applications-Monitoring and Observability-Basics of Model Monitoring-Monitoring Drift with AWS SageMaker-Monitoring Drift with Azure ML MLOps for AWS-Introduction to AWS-Getting Started with AWS Services-MLOps on AWS-MLOps Cookbook on AWS-CLI Tools-Flask Microservice-AWS Lambda Recipes-AWS Lambda-SAM Local-AWS Lambda-SAM Containerized Deploy-Applying AWS Machine Learning to the Real World Machine Learning Interoperability-Why Interoperability Is CriticalONNX: Open Neural Network Exchange-ONNX Model Zoo-Convert PyTorch into ONNX -Convert TensorFlow into ONNX-Deploy ONNX to Azure-Apple Core ML-Edge Integration. Building MLOps Command Line Tools and Microservices-Python Packaging-The Requirements File-Command Line Tools-Creating a Dataset Linter Modularizing a Command Line Tool-Microservices-Creating a Serverless Function-Authenticating to Cloud Functions-Building a Cloud-Based CLI-Machine Learning CLI Workflows Machine Learning Engineering and MLOps Case Studies	**15 hours**
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study/Flipped classroom	
References/ Readings	1. Gift, N., & Deza, A. (2021). *Practical MLOps*. " O'Reilly Media, Inc.". 2. Gift, N., & Deza, A. (2021) Introduction to MLOps – O'Reilly Media, Inc.".	
Course Outcomes	1. Integration of machine learning and software engineering for production systems. 2. Automation of model development, training, and deployment processes. 3. Scalable and reliable infrastructure design for machine learning applications. 4. Monitoring and maintenance of deployed machine learning systems.	